



The History and Ecology of Fire

in Kejimikujik National Park

Sean P. Basquill,
Stephen J. Woodley,
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July, 2001
Report 029



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Parks Canada - Technical Reports in Ecosystem Science

Report 029

The History and Ecology of Fire in Kejimikujik National Park

by

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July, 2001

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Abstract

This study illustrates the significant role fire has played in the history of Kejimikujik National Park. Kejimikujik is one of the most fire prone areas in the Acadian forest. Fire has left its mark on this land, in its history books, and in the ecology of its biota.

The functional connection between past fire occurrences and present-day forest ecology was determined using data drawn from a blending of both field and archival sources. Data were employed to determine Kejimikujik's historic fire regime, to define fire's role as a driving force in forest succession and retrogression, and to identify the park's signature pattern of post-fire forest communities and seral stages. Research findings support previous efforts showing fire's relative pervasiveness and powerful influence on local systems. This research has also served to better separate anthropogenic from lightning ignitions, comparing their frequency and extent, and contrasting their influence over space and time. Results were used to reveal fire's significance in sustaining the ecological integrity of Kejimikujik National Park and to provide a contextual framework for effective fire management.

An extensive field survey was used to identify, document, and interpret the effects of historical fire on the ecology of Kejimikujik National Park's tract of Acadian forest. Fire's presence was verified using remnant charcoal particles found either; 1) layered in soil and/or duff strata; or 2) embedded in scarred tree cambium tissue. Where information was available, efforts were made to document variation in fire intensity, frequency, and size. The effects of fire were identified where measures of forest structure and composition were found to vary with temporally or spatially localized fire events. Emphasis was placed on fire's role in shaping stand development and succession. Oral history and written archival records were also surveyed to verify and or qualify field data. An analysis of historic climatic patterns was conducted to determine the relationship between fire regime and weather.

The majority of Kejimikujik's fires occurred before the park's establishment, after which modern suppression programs appear to have virtually eliminated their occurrence. A total of 113 understory fires, with a mean point-fire return-interval of twenty-five years, were found within the 194 year period of record. Overstory fires were spatially and temporally less frequent, comprising thirteen percent of all ignitions, each burn on average eleven hectares in size.

Fire has been a major force driving the renewal of Kejimikujik's assemblage of forest communities. Typical overstory fires had a 1.2 in 100 chance of occurring in a given year; eighteen percent of Kejimikujik's forests have very likely originated from these fires. This computes to a historic fire cycle of seventy-eight years or a ten year running average of 67.6 hectares burned per year. Overstory fires initiated 100 percent of sampled red pine (*Pinus resinosa*) and sixty percent of both white pine (*Pinus strobus*) and white birch (*Betula papyrifera*) stands; to a lesser extent, these fires were shown to initiate the development of black spruce (*Picea Mariana*), red maple (*Acer rubrum*), and red spruce (*Picea rubens*) stands.

Understory fires appear to have shaped the structure and composition of both fire-origin and other-origin stands throughout the park. This fire type was, by far, the most common in the park's forest history. Understory fires have served to kill or injure flame intolerant species, shifting seral patterns and favoring fire adapted tree species and post-fire cohorts. Understory fires were shown to have strongly affected the structure and successional dynamics of hemlock (*Tsuga canadensis*), white pine, white birch, red maple, red oak (*Quercus rubra*), and red pine sites. Understory fires appear to promote self seeding in red oak, red spruce, white pine, and red pine forests.

Nova Scotia's role as an early European colony has resulted in several historical data sources dating back to 1606. Archival records reveal an abundance of both lightning and anthropogenic fires in the colony. Fire was most prevalent in southwestern Nova Scotia where a series of

barrens, within and just south of Kejimikujik, were thought to have originated and been maintained with fire. Bog and lake sediment core analyses serve to corroborate archival findings indicating the barrens originated well before European colonization. Little conclusive information was found to indicate whether first nations people did or did not use fire outside their encampments.

The relationship between fire regime and climate was explored through a series of comparative analyses. Results indicate a significant shift in the distribution of rain events throughout the period of record (1920-1994). Here total precipitation remained stable but average number of rainy days increased with a corresponding decrease in the volume of rain per event. Over the same time period, fire size decreased, a change independent of evolving fire suppression technologies. The weight of evidence suggests changing climatic patterns may have changed the area's fire regime.

Fire has had a major role in shaping successional patterns in Kejimikujik's forests. Pure red pine and red oak stands will very likely be lost from the park with continued fire suppression. Pure late-successional hemlock stands, and both pure and mixed white birch and white pine stands, will very likely change in structure and composition in the sustained absence of understory fire.

This study has very important implications for the way fire and its role in the maintenance of ecological integrity are managed within this national park. Kejimikujik's current practice of fire exclusion has served to shift the patterns of ecological structure and function inherent to the integrity of this tract of Acadian forest. The dynamics of individual forest communities and their collective contribution to landscape form and flow is skewed and incongruent with historic patterns of community structure, succession, and retrogression. Continued fire suppression will serve to maintain the trend towards a reduced representation of forest community diversity. Arguably, this has influenced the types of habitats available in the park, having repercussions for the breadth of plant and animal species the area is

able to support. Altered fire regimes can also shift patterns of nutrient cycling and hydrology, and change soil constitution and ecology.

These results have served to underscore the importance of balancing science with safety in the challenging effort to effectively manage fire in a protected ecological system. The study provides park managers with the tools they need to appropriately interpret and manage fire's ecological role in the forests of Kejimikujik. Outlined is the type, frequency, location, area, and ignition source of the fires which typify Kejimikujik's physiographic fire environment and characterize the disturbance regime of this forest landscape. These findings provide the groundwork and context for reintegrating fire into the Kejimikujik system. Managing fire to protect people and property while sustaining its requisite ecological influence is supported by Parks Canada's guiding principles and the National Parks Act

Résumé

La présente étude met en évidence le rôle important joué par le feu dans l'histoire du parc national Kejimikujik. Le parc est une des régions de la Forêt acadienne les plus susceptibles d'être touchées par le feu. Le feu y a d'ailleurs laissé sa marque partout : sur son territoire, sur l'écologie de sa biote et dans les livres qui racontent son histoire.

Nous nous sommes servis de données tirées d'études sur le terrain et de documents d'archives pour établir le lien fonctionnel qui existe entre les feux de forêt qui se sont produits jadis et l'écologie forestière actuelle. Ces données nous ont permis de déterminer le régime des feux de Kejimikujik à travers le temps, de préciser le rôle du feu en tant qu'élément moteur dans la succession et la régression de la forêt, et de définir les mécanismes de succession des communautés forestières et des étapes biotiques après le passage du feu dans le parc. Les résultats de la présente étude viennent corroborer les résultats de recherches effectuées antérieurement qui montraient l'omniprésence relative du feu et sa profonde influence sur les systèmes de la région. L'étude a également permis d'établir une nette différence entre les départs de feu d'origine anthropique et les départs dus à la foudre, de comparer la fréquence et l'étendue de ces feux, et de distinguer leurs effets respectifs à travers le temps et l'espace. Les résultats obtenus nous ont permis de comprendre l'importance du feu dans le maintien de l'intégrité écologique du parc national Kejimikujik, et fournissent un cadre de travail contextuel dans lequel gérer judicieusement les feux de forêt.

Nous avons effectué une vaste étude sur le terrain afin de déterminer, de répertorier et d'interpréter les effets des feux sur l'écologie de la zone de la Forêt acadienne que couvre le parc national Kejimikujik. Nous avons vérifié le passage du feu par les particules de charbon de bois trouvées soit 1) en couches dans le sol et/ou dans la couche supérieure de l'humus brut, soit 2) dans du tissu cicatrisé de cambium. Nous avons essayé de déterminer les différences entre les feux sur le plan de l'intensité, de la fréquence et de l'étendue, lorsque nous étions en possession de suffisamment d'informations. Nous avons pu déterminer les effets du feu lorsque les données sur la structure et la composition de la forêt ne correspondaient pas à l'étendue spatio-temporelle des feux localisés. Nous nous sommes plus

particulièrement intéressés au rôle du feu dans la formation des peuplements et la succession végétative. Nous nous sommes servis, parallèlement, de l'histoire orale et des documents d'archives pour vérifier ou nuancer les données de terrain, et nous avons également analysé les régimes climatiques à travers le temps afin de déterminer le lien qui existe entre le régime des feux et les facteurs climatiques.

La majorité des feux qui se sont produits à Kejimikujik ont eu lieu avant l'établissement du parc, après quoi, il semble que les programmes modernes de suppression des feux les aient pratiquement tous éliminés. En tout 113 feux de sous-étage forestier, avec un point moyen d'intervalle de récurrence de vingt-cinq ans, ont été recensés sur une période de 194 ans. Les feux de sous-étage, moins fréquents et moins étendus, comptent pour treize pour cent des tous les départs d'incendie, chacun ayant brûlé sur une superficie moyenne de onze hectares.

Le feu a été un élément déterminant dans la régénération des communautés forestières de Kejimikujik et dans leur mosaïque. La probabilité qu'un feu de sous-étage normal se produise dans une année donnée est de 1,2 sur 100. Dix-huit pour cent des forêts de Kejimikujik proviennent très certainement de ce type de feu, ce qui donne un cycle de feu de soixante-dix-huit ans ou une moyenne pondérée mobile sur dix ans de 67,6 hectares de forêts brûlés par année. Les feux de sous-étage sont à l'origine de 100 pour cent des pins rouges échantillonnés (*Pinus resinosa*) et de soixante pour cent des peuplements de pins blancs (*Pinus strobus*) et de bouleaux à papier (*Betula papyrifera*). Nous avons constaté que, dans une moindre mesure, ces feux sont également à l'origine de la formation des peuplements d'épinettes noires (*Picea Mariana*), d'érables rouges (*Acer rubrum*), et d'épinettes rouges (*Picea rubens*).

Il semble que les feux de sous-étage aient joué un rôle déterminant dans la structure et la composition des peuplements issus de feu et des peuplements d'autre origine dans le parc. Ce type de feu est de loin le plus fréquent dans l'histoire de la forêt du parc. Les feux de sous-étage ont éliminé ou endommagé des essences qui ne résistaient pas aux flammes, modifiant ainsi les stades biotiques et favorisant la croissance d'essences tolérantes au feu et de cohortes après feu. Nous avons pu constater que les feux de sous-étage ont considérablement

influencé la structure et la dynamique de la succession sur les sites de pruches (*Tsuga canadensis*), de pins blancs, de bouleaux à papier, d'érables rouges, de chêne rouge (*Quercus rubra*), et de pins rouges. Ce type de feu semble également favoriser l'auto-ensemencement dans les forêts de chênes rouges, d'épinettes rouges, de pins blancs et de pins rouges.

Le fait que la Nouvelle-Écosse ait été jadis une colonie européenne nous a permis de consulter plusieurs sources d'informations remontant à 1606. Ces archives révèlent qu'il s'est produit dans la colonie un grand nombre de feux d'origine anthropique et de feux dus à la foudre. Les feux étaient plus fréquents dans le sud-ouest de la Nouvelle-Écosse, où ils auraient été à l'origine de la formation et du maintien des landes situées à l'intérieur et juste au sud de Kejimikujik. L'analyse de carottes de sédiments de tourbière et de lac a permis de corroborer les résultats de l'étude des archives, révélant que la formation de ces landes est bien antérieure à la colonisation par les Européens. Nous ne possédons pas suffisamment d'informations pour savoir si les membres des Premières nations faisaient usage ou non du feu à l'extérieur de leurs campements.

Nous avons étudié le lien entre le régime des feux et le climat au moyen d'analyses comparatives. Les résultats de ces analyses révèlent un important changement dans la distribution des précipitations pendant la période répertoriée, soit de 1920 à 1994. Si les précipitations totales sont demeurées stables dans la région du parc, par contre, le nombre moyen de jours de pluie a augmenté, tandis que la quantité de pluie par précipitation a diminué. Pendant cette même période, la taille des feux a diminué, indépendamment des progrès techniques réalisés dans la lutte contre les incendies. Il est donc permis de penser, à la lumière de ces constatations, que les régimes climatiques changeants ont pu influencer sur le régime des feux de la région.

Le feu a joué un rôle déterminant dans la formation des stades de succession des forêts de Kejimikujik. Il est pratiquement certain que les peuplements purs de pins rouges et de chênes rouges vont disparaître du parc si la lutte contre les feux se poursuit. Les peuplements purs de pruches qui se sont formés à un stade de succession plus tardif, et les peuplements purs et mélangés de bouleaux à papier

et de pins blancs verront très certainement leur structure et leur composition se modifier en l'absence prolongée de feux de sous-étage.

La présente étude a d'énormes conséquences quant à la façon de gérer dans le parc national le feu et son rôle dans le maintien de l'intégrité écologique. La pratique actuelle de suppression des feux à Kejimikujik a entraîné une modification des mécanismes des structures et des fonctions écologiques qui sont inhérents à l'intégrité de cette zone de la Forêt acadienne. La dynamique des communautés forestières individuelles et de leur contribution collective à la formation et à l'évolution du paysage sont faussées et incompatibles avec les mécanismes qui influaient jadis sur la structure, la succession et la régression de ces communautés. Continuer à empêcher l'action naturelle du feu ne fera que renforcer la tendance amorcée et appauvrir encore davantage la diversité des communautés forestières. De toute évidence, la suppression des feux influe sur les types d'habitats disponibles dans le parc et, partant, a des effets sur la diversité et le nombre des espèces végétales et animales que la région peut accueillir. La modification du régime des feux risque également d'entraîner un changement dans le déroulement du cycle des substances nutritives, les mécanismes hydrologiques, et la constitution et l'écologie des sols.

Les résultats de la présente étude font ressortir combien il est important de trouver un juste milieu entre science et sécurité dans l'exercice délicat de gérer convenablement le feu à l'intérieur d'un système écologique protégé. L'étude fournit aux gestionnaires du parc les outils dont ils ont besoin pour interpréter et gérer judicieusement le rôle écologique du feu dans les forêts de Kejimikujik. Elle précise le type, la fréquence, l'emplacement, la région couverte et l'origine des feux qui caractérisent l'environnement physiographique lié au passage du feu à Kejimikujik et le régime de perturbation de ce paysage forestier. Les résultats de l'étude préparent le terrain et donnent le contexte nécessaire pour réintroduire le feu dans l'écosystème de Kejimikujik. Gérer le feu afin de protéger les personnes et les biens, tout en maintenant son influence écologique indispensable, s'inscrit d'ailleurs dans l'esprit des principes directeurs de Parcs Canada et de la Loi sur les parcs nationaux.

1.0 Introduction

Kejimikujik National Park (KNP) was established in 1968 to protect an element of ecological and cultural heritage unique to the southwestern portion of Atlantic Canada. The park lies approximately half-way between Nova Scotia's two coasts (see Figure 1), occupying an area of 381 square kilometers. Kejimikujik is characterized by a gently rolling post-glacial topography. The area is marked by boulder fields, scattered with eskers and drumlin ridges, and interspersed with

several shallow stream, river valley, and lake beds (Gimbarzevsky 1975). Most notable is the park's namesake lake and one of Nova Scotia's largest rivers, the Mersey and its tributaries (Figure 2).

Kejimikujik National Park is part of a region having the warmest mean annual temperatures in Eastern Canada (Watson 1974, Shaw 1997). This relatively moderate climate helps support disjunctive plant and animal species otherwise found as far north as Massachusetts (Bleakney

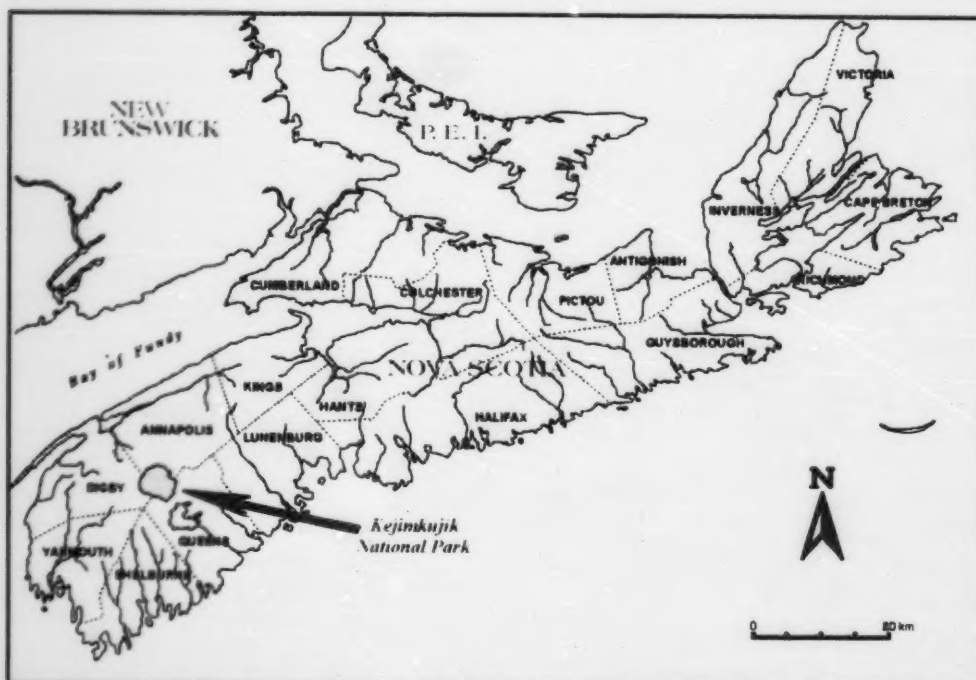


Figure 1. Kejimikujik National Park's location in Nova Scotia, Canada. Nova Scotia's county lines are indicated.

1963, Drysdale 1986).

For centuries native Mi'kmaq peoples used the Kejimikujik region extensively as a hunting and foraging ground, but more importantly as part of a travel route between Nova Scotia's two coasts (Speck 1922, Morrison and Friend 1982, Drysdale 1986). With the coming of Europeans in late sixteenth century, however, numbers of Mi'kmaq began to diminish. Those natives that remained began farming around the park's lakes and later established trade partnerships with the European settlers (Morrison and Friend 1982). Today Kejimikujik's Mi'kmaq history is readily apparent in the vestigial petroglyphs still found dotting its lakeshores (Figure 2), and in the park's name itself, which is Mi'kmaq.

Following the first permanent settlement in the 1799, immigrant populations of European colonists rose steadily throughout the Kejimikujik region (see Drysdale 1986 for review). This rapid colonial growth was sustained by the efficient transport of both farm and forest mainstay commodities across Kejimikujik's prevalent waterways. In the beginning of

the twentieth century, these same lakes and rivers also served as the basis for a thriving recreational industry. During this period, several gold mines were established, including three in the park. Remnant piles of sawdust, crumbling structural foundations, and abandoned mine shafts lie scattered throughout Kejimikujik's present day forests.

Kejimikujik National Park falls into the Atlantic Coast Uplands Section of the greater Acadian Forest Region (Rowe 1972). Rowe (1972) broadly distinguished this region by the relative uniformity of dominant tree species distributed throughout it; he attributed variability in species composition amongst regions to climate. Red spruce (*Picea rubens*), balsam fir (*Abies balsamea*), sugar maple (*Acer saccharum*), and yellow birch (*Betula alleghensis*) all feature strongly in the Acadian forest's canopy layer (Rowe 1972).

Rowe (1972) divided the Acadian forest into seven subsections, including the Atlantic Coastal Uplands, a relatively large area covering half of mainland Nova Scotia. Sections were delineated on the

basis of recurring tree communities. The Atlantic Coastal Uplands' forest mosaic is less boreal than many other areas of Acadian forest, characterized by elevated levels of pine (*Pinus* spp.), hemlock (*Tsuga canadensis*), red maple (*Acer rubrum*), and red oak (*Quercus rubra*)(Rowe 1972).

Kejimikujik's three types of bedrock are overlain with an abundance of post-glacial

land forms (Drysedale 1986). These two physiographic layers are in turn major factors in determining the park's assemblage of forest communities (Gimbarzevsky 1975)(see Table 1). Kejimikujik's granitic and quartzite plains are covered with a softwood dominated forest of red spruce, white pine (*Pinus strobus*), and fir. Large stands of pure pine are also common here and in the drier drumlin areas, hemlock

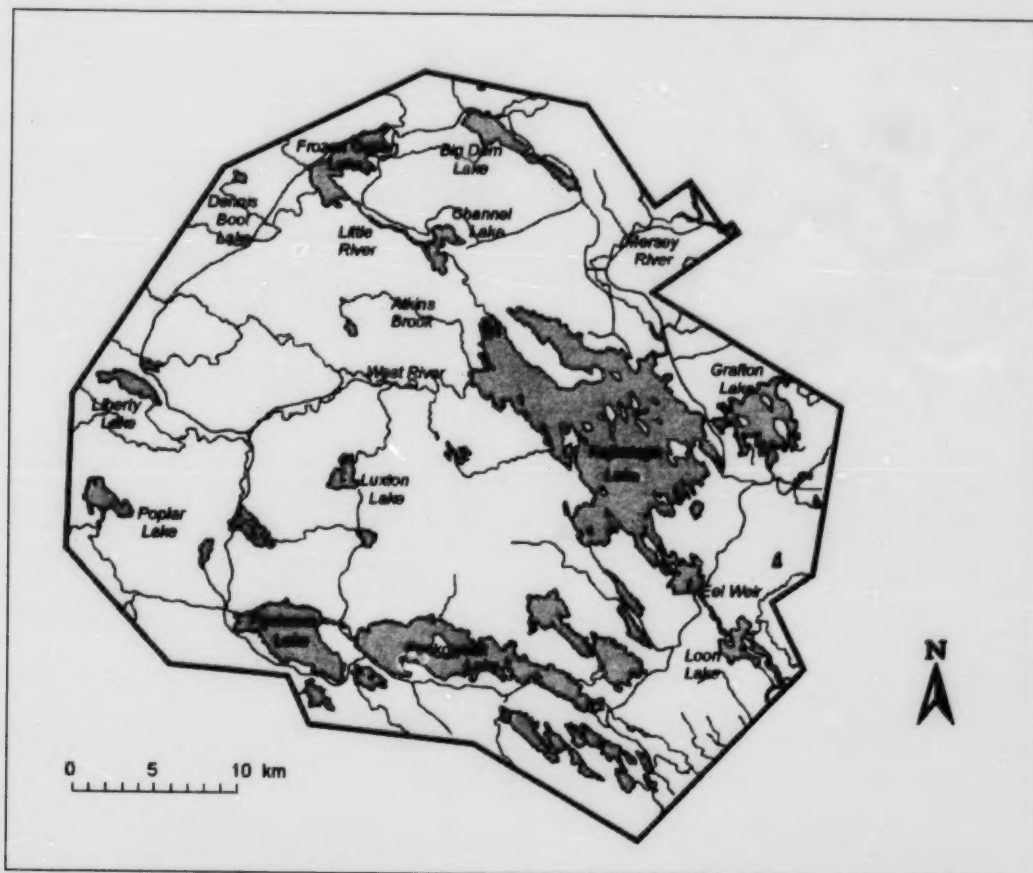


Figure 2. Kejimikujik National park showing major river and lake bodies, primary road and trailways, and the park's political boundary.

(Gimbarzevsky 1975). A mixed forest of pine and hemlock predominates over Kejimikujik's slate underlay. Here, additional forest components include late successional stands of sugar maple and beech (*Fagus grandifolia*), and pocket stands of pure red oak (Gimbarzevsky 1975). Gimbarzevsky's (1975) classification of the Kejimikujik forest is dated but provides the most comprehensive outline of its community associations (Table 1).

Kejimikujik's disturbance history is reflected in the significant structural variability found amongst its forest communities. The area has been heavily influenced by both its local logging and agricultural industries, and shows substantial evidence of fire (Gimbarzevsky 1975). These forests have thus been shaped by a disturbance regime that varied not only in space and time but in intensity and constitution. Gimbarzevsky's (1975) summary of Kejimikujik's forest disturbances patterns is given in Table 2.

Most of Nova Scotia's Acadian forest has originated or been shaped with logging disturbances (Lynds 1992). Across

Canada, no other forest region shares as long a harvest history. Even as early as 1910, Fernow (1912) estimated that less than 41 000 hectares (2.5 % of total forested area in province) of forest remained untouched. Rowe (1972) suggests the practices have changed the forest entirely; historic Acadian forests were likely a blend of pure and mixed, early and late successional stands. Eastern hemlock, red oak, and white pine were far more common. Although logging and farming are now excluded from the Kejimikujik landscape, current forests bear clear record of their disturbance history. Compared with historic stands, KNP's forests support far more early successional species; they are also younger and less structurally diverse (Gimbarzevsky 1975, Drysdale 1986).

Fire can serve to reorganize the frequency, abundance, and arrangement of different age classes and community types across a landscape (Chandler et al. 1983). In environments where fires occur regularly, some species have

Table 1. Forest associations of Kejimikujik National Park (adapted from Gimbarzevsky 1975). Dominant species are followed by co-dominants in each listing; subdominants are given in parentheses. See Appendix A for breakdown of tree species acronyms.

Association	Characteristics	Comments	Area of KNP
1. Wetland// bS-rM a) bS-La-rM b) bS-bF-rM	La in wetter sites; BF in drier sites	La replaced by bF with time	18%
2. Upland//rS-bF-wP (and hardwoods) a) rS-bF-Pine-(rM-wB) b) rS-bF-Pine-(rM-wB-rO) c) rS-bF-Pine	Stands of mixed heterogeneity; (two times more rS than pine and bF together)	Much evidence of fire and logging - shift to pure conifer in absence of future disturbance	32%
3. Upland//rS-He-wP (and hardwoods) a) rS-He-Pine (rM-wB) b) rS-He-Pine (rM-wB-rO) c) He-rS-Pine	Some large relic stems; He dominant on dryer drumlins in c); (some rP and ItA)	Trend toward pure coniferous; selective cutting and fire have resulted in hardwood invasion in a) and b); c) is near climax (undisturbed)	9%
4. Upland//wP-rS (and hardwoods) a) wP-rS (rM-wB) b) wP-rS/wS	Multi-aged, different heights and densities, usually on well drained sites	Selective logging resulted in uneven mixed stands; trend to pure conifer with pockets of hardwood	8%
5. Upland//wP/rP	Pure white or red pine stands of 3 types: 1) widely-spaced wP having escaped fire. 2) old field wP stands 3) rP on lakeshores and in small pockets.	There are few large old white pine trees as the species was harvested extensively. There are few red pine stands.	9%

evolved traits which give them a competitive advantage, or higher fitness, in the development and succession of post-

fire communities (Chandler et al. 1983). As such, the pattern of forest community types recurring across a landscape can be

heavily influenced by both the periodicity, size and intensity of fires common to it (fire regime)(see Chandler et al. 1983, Wein and MacLean 1983, and Agee 1993 for review).

Historically, western Nova Scotia has been the most intensely burned area of the province (Johnson 1986). Survey accounts dating as far back as Denys (1672), Perkins 1766 (1948), Smith (1802), Fernow (1912), and more recently Candy

(1951), Martin (1956) and Gimbarzevsky (1975) have clearly indicated this force's preponderant influence on regional forest ecosystems. Repeated burns were common, often creating fire barrens or areas where frequent blazes prevented seed germination, even in flame tolerant species (Smith 1802, Hardy 1869, Fernow, 1912, Strang 1972, Gimbarzevsky 1975). Gimbarzevsky (1975) estimated that few, if any, parts of Kejimikujik had escaped ignition. In most cases, survey accounts

Table 2. The temporal and spatial characteristics of KNP's historic disturbance events and their visible effects, circa 1971. Information has been adapted from Gimbarzevsky (1975). Tree species acronyms are given in Appendix A.

Disturbance	Period	Extent	Visible Effects in 1971
Agriculture	1872-1972	On drumlin areas	Exotics, some old fields growing in with wP
Selective logging	1840-1870s	Widespread	Mostly wP and rO taken, possibly He; few large stems of such species exist today
Clearcutting	1901-1950	Widespread	Contributed to semi-mature status of many stands; rarity of primary old-growth forest
Recreation	1906-	Localized	Clearings, tramlings
Fire	??	Widespread	Major contributor to semi-mature status of park forests
Wind	Not available	Localized	Isolated pockets
Insects/disease	Not available	Local and widespread	Affects Be, La, bF

did not include a record of ignition source, although evidence suggested that historical fires originated from both human and non-human causes.

Historical fire records are typically subjective and anecdotal, reducing their utility in fire ecology is minimal at best. The problem is further compounded by the emphasis archives place on fires that were encountered or fought by humans; the majority of these fires were only accurately recorded in recent history (1960-present) and are size restricted by their likelihood of being detected. Small or low intensity fires are less easily detected but can have marked influence on forest structure.

Historical records best serve to coarsely qualify common ignition sources, fire frequency and size in a given area.

Previous fire history studies conducted in the Acadian forest have relied on reviews of historical archives (e.g. Wein 1977) and or sediment profiles analyses (Wein and Moore 1977, 1979, Green 1982, Wein et al. 1987). Sediment profile analyses are broad historical surveys; they typically account for changes in airborne charcoal over periods of centuries, across hundreds of hectares and are best used to compare

fire activity at the landscape or geographic scale.

Very little field data has been collected to ascertain fire's influence on the Acadian forest. In Nova Scotia, no empirical field data on fire history has ever been collected.

Canada's national parks are mandated to protect and maintain the parts and processes representative of the ecoregions they are a part of (Parks Canada Guiding Principles and Operational Policies 1994). In application of this standard, Parks Canada's ecosystem management strategies and goals have been designed to;

- 1) identify parts and processes inherently representative of each protected ecoregion;
- 2) identify stressors to this assemblage of parts and processes;
- 3) design management protocol to reduce stress levels to within acceptable limits.

These management goals are reflected in the following relevant statements from Parks Canada's Guiding Principles and Operational Policies (1994):

~ *National parks will be managed with minimal interference to natural*

processes; where management intervention is required, techniques will duplicate natural processes as closely as possible

- ~ Management intervention is prescribed when the goals of unimpaired ecosystem structure and function have been seriously altered and when intervention is the only reasonable alternative to restore ecosystem integrity*
- ~ When management interventions are required, they will be based on scientific research, will duplicate natural processes as closely as possible, and will be carefully monitored.*

Fire is a natural process. It falls into the host of agents potentially influencing ecosystem function in Kejimikujik National Park and thus lies within the context of Parks Canada's policy for protection and or maintenance. As such, a comprehensive fire history study was needed to determine fire's role in the ecology of the park's Acadian forest.

Fire history studies are aimed at determining the characteristics of past fires

and to infer their ecological role in structuring and shaping forest ecosystems. This study examined Kejimikujik's fire history, including, but not limited to, the timing, cause, location, and extent of past forest fires, as far back as the field evidence and historical references allowed.

The general hypotheses employed in this study are as follows:

- 1. Fire has played a significant role in the current structure of forest types in KNP*
- 2. In the absence of fire, several forest types will be lost to the park.*

The authors conducted an extensive field survey of KNP's forests, indexing both their structure and fire history. Field data was supplemented with historical information on Kejimikujik's forests, logging activities, and forest fires. An analysis of southwestern Nova Scotia's past fire weather patterns and their relationship to ignition frequency and fire behaviour was also conducted. This study was designed to 1) determine the life history response of Acadian forest tree species to fire; 2) separate the occurrence and influence of anthropogenic and lightning fires; 3) ascertain the influence of fire on stand structural attributes such as

age class, species composition, and non-tree associations; 4) understand fire's role in stand succession, retrogression, and rotation; 5) determine landscape-scale functional responses to the area's pre-colonial, pre-suppression, and suppression era fire regimes; 6) identify the presence and influence of smaller scale and lower intensity understory burns; and 7) support both fire and vegetation management programs in Kejimikujik National Park.

2.0 Methods

2.1 Field survey

2.1.1 Sampling site selection

Sample sites were drawn from Kejimikujik's two biophysical databases. The park has conducted biophysical surveys (herein used interchangeably with ecological land classification (ELC)) in both 1971 and 1992. Spatial data from each survey have been incorporated into a SPANS 6.0 (Tydac Research Incorporated 1996) geographical information system (GIS).

Kejimikujik's first ELC was established from aerial photograph interpretations and an extensive field survey (Gimbarzevsky 1975). Aerial photographs utilized for the

classification were drawn from two series: black and white infrared photographs acquired in 1971 at 1:12000 and similar 1:15840 photographs collected in 1968. Gimbarzevsky's (1975) ELC is maintained in a gazetteer at a scale of 1:12500.

Kejimikujik's 1992 survey was derived from forest inventory data, collected by the Nova Scotia Department of Natural Resources (NSDNR), using aerial photograph interpretations and on site reconnaissance sampling (NSDNR 1994). Photographs utilized for this survey were drawn from two series, 1988 colour 1:50000 and 1992 colour 1:50000. NSDNR survey data is maintained in a map library captured at a 1:10000 scale. Maps from both the 1971 and 1992 surveys were converted to digital format, using a digitizing table, before their incorporation into the park's GIS databases.

The density, height, and condition of dominant canopy species were used to describe forest classes in both biophysical databases. Similar descriptions of subdominant and understory forest strata were included within the 1971

classification. Nonforest cover types such as old fields, heath bogs, marshes, recreational areas, roads, trails, and waterways were also noted in the two databases.

Sample sites within Kejimikujik National Park were identified according to an array of systematic and nonsystematic selection criteria, with sampling occurring at the scale of the forest stand. Biophysical data were used to differentiate individual stands according to their composition of dominant canopy species. Candidate sample stands were randomly drawn from a subset of all forest stands identified in each biophysical database. Stands included in the subset were only those with a subjectively defined probability of having originated following a major, or stand-replacing, disturbance event (*sensu* Oliver and Larson 1990). The potential influence minor disturbance events (*sensu* Oliver and Larson 1990) had on stand development was not considered in sample site selection.

Major disturbances were defined as those disturbances that remove all or most trees from an area. Overstory or stand-replacing

fire is a classic example. Stands developing after such disturbances often exhibit a dominant single-cohort, single-species canopy structure (Oliver and Larson 1990). As the park's biophysical databases offer little accurate canopy age data, post-disturbance stand types were subjectively defined as those stands with a single-species (homogenous or pure) canopy structure. Stands with species diversities singularly dominated by at least fifty percent were defined as single-species stand types. Single-species stands showing higher levels of canopy homogeneity were assumed to be more likely of having post-fire disturbance origins.

The following assumptions were made in choosing to use single-species stands to sample Kejimikujik's fire history:

1. Kejimikujik's major fire events removed all or most trees from each affected area.
2. The large majority of stands originating from other types of major disturbance, such as logging, faunal predation, wind, and agriculture, were known; such stands were avoided.

3. As development patterns in post-fire sites are almost always researched at the species level (e.g. Wright and Bailey 1982, Agee 1993, VanWagner 1993), it was reasoned that fire's effect in Kejimikujik's purest stands would be the clearest to define.
4. The majority of Kejimikujik's single-species stand types are dominated by tree species known to form pure stands after fire events (e.g. white pine, black spruce, red pine, eastern hemlock, red oak (Burns and Honkala 1990)). These species were assumed to respond to fire similarly, throughout their range (but see Rowe 1983).
5. Kejimikujik's purer stands were *a priori* assumed to likely contain more evidence of minor fire events than other stands. Minor fire events, also called surface, stand maintenance and or understory fires, can serve to kill flame intolerant species, shifting overall species composition, and favouring fire adapted species (Kimmins 1997, Oliver and Larson 1990). Although the influence minor fire events can have on stand structure was considered relevant to the study, the difficulties posed in *a priori* using

biophysical data to identify areas shaped under their influence, precluded our considering them as a primary selection criterion in sample site identification.

To identify samples with probable disturbance-origins, two independent GIS database queries were conducted to isolate the most homogenous single-species stands identified in each biophysical database. In querying for suitable stands, a minimum polygon area was set at 1.5 hectares, based on the smallest stand size of the least represented single-species cover type.

To search the 1992 biophysical database, a series of successive queries was conducted to identify single-species stands of increasing homogeneity. Table 3 outlines two such series for example. Queries were devised to isolate single-species stands falling into one of six continuous classes of homogeneity; class intervals were fixed at 10 percent.

Query results revealed Kejimikujik's most homogeneous stands were also its least common (Table 3). In some cases, this

restricted their statistical utility as sample sets. As such, query data were used to selectively maximize both stand homogeneity and stand number. The homogeneity class used to define each single-species sample set was subjectively fixed at a level of homogeneity above which corresponding stand numbers were deemed insufficient to ensure statistical confidence (see Table 3).

The organizational format of the 1971 GIS database did not allow the same latitude for maximizing homogeneity. Here, stands with species diversities singularly dominated by at least thirty percent were utilized to define disturbance-origin cover types. The querying process resulted in two sets of candidate sample stands, one drawn from each of the respective biophysical databases. To reduce

replications, cross-references were made between each sample set. Duplicate stand types were omitted in favour of the more recent 1992 classification. Several stand types identified in the 1971 classification were not accounted for in the 1992 classification. These included black spruce, red maple, and white birch. The potential role of major fire disturbances in the development of these three species, (e.g. Viereck and Johnston 1990 (black spruce), Saunders 1970 (red maple), Farrar 1995 (white birch)), warranted their inclusion (Table 4) in the sampling regime.

The same rationale was employed for including a mixed softwood stand type from the 1992 classification (Table 4). Kejimikujik's mixed softwood stands are boreal-like in nature, characterized by high

Table 3. The result of a series of GIS queries for homogenous stands of both red spruce and red oak. Indicated for each query are the number of stands characteristic of each homogeneity class. Such series were used to identify sample sets for each stand type. The homogeneity class used to define each single-species sample set was subjectively fixed at a level of homogeneity above which corresponding stand numbers were deemed insufficient to ensure statistical confidence.

	Stand Type	Query Number (Homogeneity Class)					
		1 ($\geq 50\%$)	2 ($\geq 60\%$)	3 ($\geq 70\%$)	4 ($\geq 80\%$)	5 ($\geq 90\%$)	6 ($\geq 100\%$)
Number of stands isolated	Red spruce	301	266	197	134	121*	24
	Red Oak	22*	7	1	0	0	0

*set of stands selected for sampling

levels of spruce, with lesser amounts of intolerant hardwood and balsam fir. Database queries for this stand type were used to maximize the relative percent dominance of spruce, while maintaining the percent of intolerant hardwood at 20% or more. As fire plays a significant role in the ecology of the boreal forest (see Wein and MacLean 1983), the park's mixed softwood stand type was included in the sampling regime.

The classification scheme used in the 1992 NSDNR forest survey presented some problems for sampling spruce forest. The survey classed both black and red spruce stands as one stand type, *Picea* spp., thereby eliminating any possibility of using sampling data to separate the effects of fire on each species. To address this, annotated GIS maps were used to identify 1992 NSDNR spruce stands that overlapped with black spruce forests outlined in the park's 1972 ELC. Overlapping stands were removed from the statistical population; remaining spruce stands were reclassified as red spruce (white spruce was not a common canopy tree in this part of the province). Despite this,

field observations revealed a relatively high percentage of the red spruce stands, *a priori* identified using this method, were concentrated with black spruce. These sites were removed from the sampling regime.

Single-species stands, drawn from each of the respective biophysical databases, were ranked according to their likelihood of having originated with fire (Table 4, Figure 3). Rank-classes included: 1) stands likely of fire-origin, 2) stands potentially of fire-origin, and 3) stands unlikely of fire-origin. Each stand type's assigned fire-origin rank was derived from previous research into post-fire stand development patterns (e.g. Wright and Bailey 1982, Burns and Honkala 1990). Table 4 provides a summary of all stand types identified for sampling and their corresponding fire-origin rank. An annotated GIS map of Kejimikujik, showing the spatial distribution of stands falling into each fire-origin rank-class, is given in Figure 3.

Since Kejimikujik's inception, park staff have established a database of forest fires

having occurred within, and in the immediate vicinity of, the park's political boundaries. The database chronicles the size, location, date, and cause of known forest fires. These sites were incorporated into the sampling regime in an effort to document forest structure in areas with a known disturbance history of forest fire (Table 4).

2.1.2 Sampling regime

In this study, the statistical test groups of interest were the different fire-origin rank classes. As no fire history field data has ever been collected in Nova Scotia,

variability among test groups could not be *a priori* estimated or predicted with any confidence. Sampling effort was therefore equally apportioned to stands falling into both the 1) *likely of* and 2) *possibly of* fire-origin classes. Time restrained efforts to sample stands *unlikely* to have originated with fire. This stratified sampling regime is more accurate than simple sampling, where no zonation exists, but it is biased as it fails to weight sampling effort proportional to the variability amongst strata.

Table 4. Summary of sites identified for sampling. Sites include those with both known and hypothesized post-fire origins. Sampling sites were drawn from a 1992 NSDNR biophysical classification, Gimbarzevsky's 1971 ELC, and Kejimikujik's archival history of known forest fires. Included in the summary is a record of the number, percent (%) homogeneity, and fire-origin (FO) rank of each stand type. Ranks correspond with each stand's likelihood of having originated with fire. Ranks were designated based on previous research into post-fire stand development patterns. (na - not available/not applicable, NSDNR - Nova Scotia Department of Natural Resources)

Site Type	Species	Database	#	%	FO Rank
Forest stand	Hemlock	1992-NSDNR	85	85	Possible
Forest stand	Mixed Softwood (S/IH)*	1992-NSDNR	105	62/20	Likely
Forest stand	Red oak	1992-NSDNR	22	57	Possible
Forest stand	Spruce (red) ¹	1992-NSDNR	121	91	Likely
Forest stand	Red pine	1992-NSDNR	9	76	Likely
Forest stand	White pine	1992-NSDNR	748	85	Likely
Forest stand	Black spruce	1971-Gimbarzevsky	29	>30	Possible
Forest stand	Red maple	1971- Gimbarzevsky	161	>30	Possible
Forest stand	White birch	1971- Gimbarzevsky	8	>30	Possible
Known burn	na	Kejimikujik Archives	21	Na	na

* Mixed softwood stands are classified in the 1992 NSDNR forest inventory as those dominated by a mix of spruce (S) and intolerant hardwood (IH).

¹ NSDNR uses its *spruce* stand class to define canopies dominated by black and or red spruce.

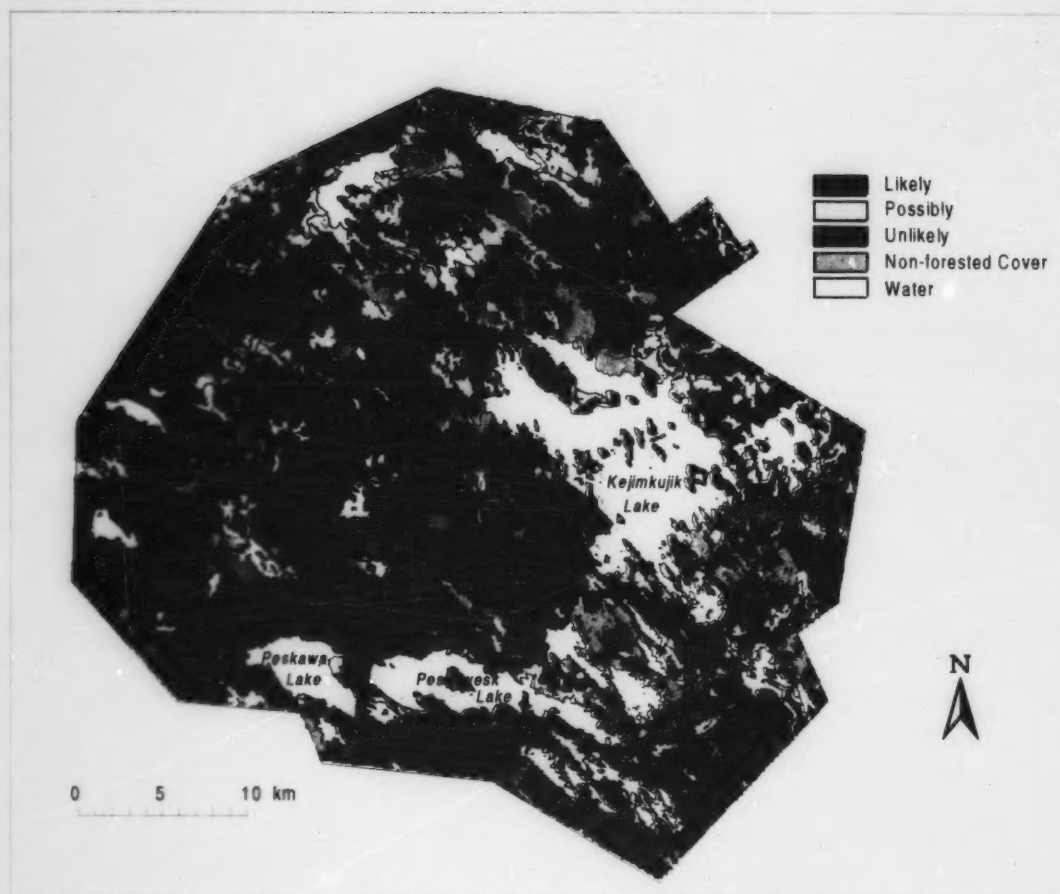


Figure 3. *Kejimikujik National Park showing the spatial distribution of stands likely, possibly, and unlikely to have originated with fire. Each single-species stand type's assigned fire-origin rank was derived species specific research into stand development.*

Five sample sites of each stand type were randomly identified for sampling. Sample effort was set by allotting an equal portion of the field season to each stand type.

Stand sampling began in late June, 1997, starting after the relative burst of annual primary productivity in the spring leveled out, and ending in late September 1997, before the herbaceous annuals began to die off and the trees markedly changed their

photosynthetic patterns. Three known-burn sites were also selected for sampling (Table 4); effort was made to diversify the date of fire, location, and spatial extent of selected burn sites.

2.1.3 Site distribution

Annotated GIS maps of Kejimikujik National Park were created, including the forest stands identified for sampling, a

2.1.3 Site distribution

Annotated GIS maps of Kejimikujik National Park were created, including the forest stands identified for sampling, a NAD 27 UTM (universal transverse mercator) grid, a compass bearing, waterways, roads and railways, and recognizable land features (Figure 4). These maps were used to select sampling sites and establish navigational routes.

A randomization function, provided by the GIS software, was used to select sample sites. Where selected samples of a given stand type were densely clumped, they were subjectively spread more evenly across the park. In these cases, some sites were designated for relatively inaccessible areas. In such situations, aerial photographs and reconnaissance helicopter surveys were utilized to determine sampling feasibility. Here a given stand's proximity to an appropriate helicopter landing site (bog, lake shore, or marsh) was the principal criterion for selection.

2.1.4 Sampling schedule

The order at which each site was sampled during the field season was also

randomized where possible. In some cases it was more practical to sample several proximate sites within a given time frame. Approximately one sample day was needed to sample every two sites.

2.1.5 Sampling parameters

Square, 10 x 10 square meter, survey plots were utilized to characterize forest structure in sample stands. Plot area was sufficiently large to index forest structural parameters but small enough to satisfy practical concerns.

Plot location was randomly fixed within each sample stand. To avoid possible edge effects, and to ensure independence amongst samples, a twenty-five meter (see Luttmerding et al. 1990) buffer strip was maintained between a given plot and adjacent stand boundaries, anthropogenic disturbances, and other plots. All plots were oriented in the same juxtaposition, relative to the point *a priori* established for their location.

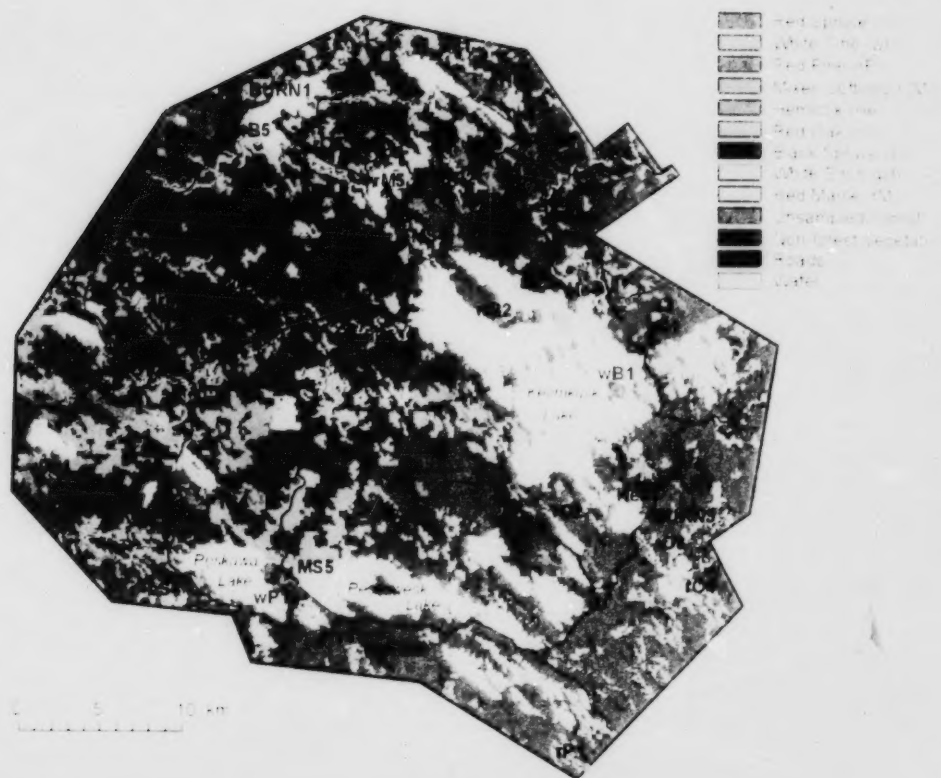


Figure 4. *Kejimikujik National Park showing the different stand types identified for sampling, the location and identification code of each sampling site, major water bodies, roads and trailways, and the park boundary.*

2.1.6 Data Collection

An outline of the field equipment used can be found in Appendix N. Stands were accessed by foot, truck, all terrain vehicle, canoe, and or helicopter. Stands were located using maps, GPS, compass, and aerial photographs.

2.1.7 Plot parameters

Plot lines were fixed using a compass and hip chain, their corners marked with a

fluorescent peg. Subplots, of two by two meters, were laid out in the southwestern and northeastern corners of each plot.

2.1.8 Site physical attributes

Following each plot's establishment, several attributes were measured to characterize the area's physical structure and geographic location, and to document the time and circumstances of sampling

(see Appendix B). A photograph of each plot and sample stand was taken.

2.1.9 Forest structural data

Canopy, understory, and ground layer structure was measured across each plot (see Appendix B). Canopy layers were characterized in terms of crown closure, species composition, mortality, tree age, and tree size. Crown closure was indexed using the average of three spherical densiometer readings taken randomly across each plot. Species composition was estimated from the percent of canopy occupied by the five most dominant tree species. The mortality class (see Appendix C) of each stand was determined based on the condition of the majority (greater than fifty percent) of stems. Tree age and size data was derived for canopy and subcanopy layers from a representative subsample of tree stems (Appendix B).

Understory layers were described, using subplot data, in terms of tree recruitment and shrub and tree physiognomies. The height, diameter, species, and condition (see Appendix C) of each shrub and understory tree (two meters or less in height) was measured across each subplot.

Stems less than five centimeters in height or 0.1 centimeters in diameter were not measured but were still counted and keyed.

All plant species, covering the forest floor were documented and described as was the physical structure of the floor itself (see Appendix B). The four most dominant ground species within the plot were recorded as percentages. Within each subplot, the procedure was repeated for all herbaceous and shrub species. The mean ($n=5$) herbaceous height and height to live understory crown was taken.

2.1.10 Forest fire fuel types and loading

Forest fuels were described in terms of the abundance, type, and spatial clumping of both surface and ladder fuels (see Appendix B). Surface fuels found in each size class (fine litter (needles, twigs, leaves), branches (greater than four centimeter diameter), and boles (stumps or branches greater than twenty centimeter diameter)), were recorded as percentages; both fuel density (scattered, light, or heavy) and degree of decomposition (intact or not intact) were also noted. Ladder fuels were characterized using the height of herbaceous flora, the base to tree

crown height, and a record of whether tree branches touched the ground.

2.1.11 Fire history data

Each sample stand was searched extensively for evidence of past fires (see Appendix B). The search included a survey of duff, soil, roots, snags, and scarred trees for charcoal evidence (see Figures 5 and 6 for example). As part of the study, 48 fire-scarred trees were cut down across the park; representative stem cross-sections were sampled from each and retained for analysis. The following mitigative measures were implemented to reduce ecological impacts on the park's forests and on the quality of visitor experience:

1. All efforts were taken to avoid disturbing visitors.
2. No very large or old trees were cut in recognition of their rare status in Nova Scotia. This was especially true of 300+ year old hemlock and pines. Only trees with breast height diameters less than seventy centimeters were taken.
3. A maximum of two fire-scarred trees were taken per stand.

4. All sampled trees were left as natural wind-throws.
5. No trees were cut within fifty meters (or as deemed appropriate by way of visibility) of a trail, road or campsite.
6. Chainsaws were only used outside the main visitor season (after Labour Day). Cross-sections were extracted with a chain saw, or with a buck or cross-cut saw in areas where noise would cause disruption.
7. For safety purposes, all cutting of trees was carried out by a professional chainsaw operator, with at least one other person present.
8. All stem cross-sections were marked and stored for future studies or as resources for park information programs.

Data collected from sampled fire-scarred trees included: date of felling; sampling site; species; breast-height-diameter; scar height of the dominant external scar; the number of external scars; scar aspect; site slope and aspect; crown mortality, and; the height, along the stem, at which the cross-section was sampled. A photograph was taken of each scarred tree, the cross-

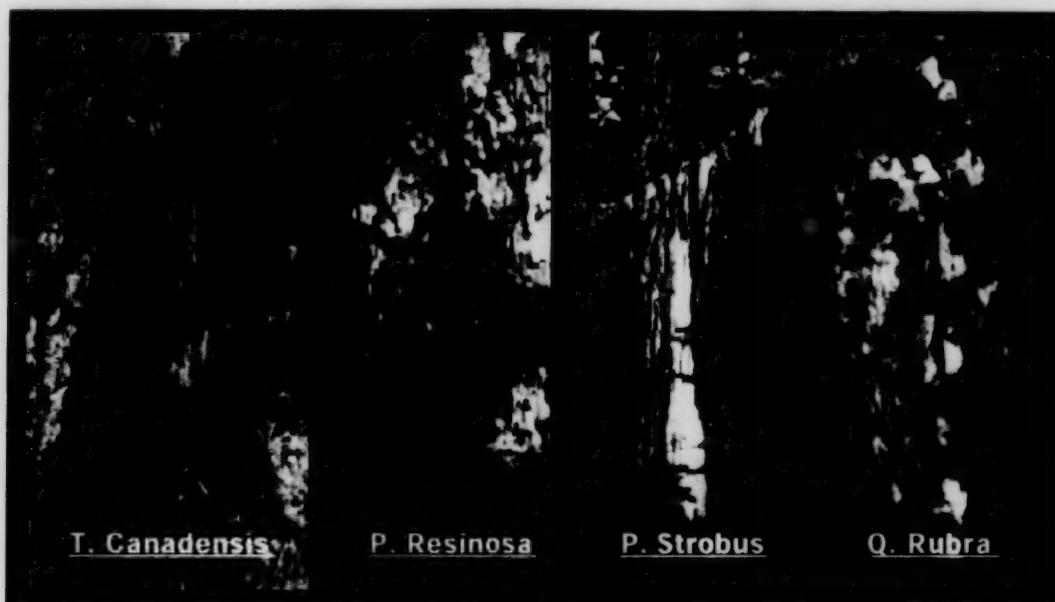


Figure 5. Stereotypic examples of fire scar evidence found on *Quercus rubra*, *Tsuga Canadensis*, *Pinus resinosa*, and *Pinus strobes* trees found Kejimkujik National park.



Figure 6. Examples of fire evidence found on deadwood and in soil/duff samples from Kejimkujik National park.

section extracted from it, and its fire-scarred growth rings.

Cross-sections were inspected in the field for evidence of fire in the growth rings. The cross-section providing the maximum record of fire events was retained for lab analysis. In instances where a fire scar was not suitable for extraction, increment core samples were taken following the methods outlined in Barrett and Arno (1988).

Tree cross sections were treated with shellac to moderate the drying process. Shellaced cross-sections were dried on racks in a cool humid environment for one to three weeks. After drying, each cross-section was belt-sanded and then finished with one to two coats of clear-finish polyurethane.

Fire frequencies and dates were recorded following a detailed examination and interpretation of each cross-section. A powerful fluorescent laboratory bench lamp, a Wild M38 6.8 – 40x stereoscope, 0.01% methylene blue, 0.01% gentian violet, glycerin and a dissecting kit were used for the examination.

2.2 Data analysis

To avoid conflicting biases between field and archival (see section 2.4) data sets, field survey results were regarded as the primary source of data. All analyses were conducted using field data. These included methods for determining: 1) each sample stand's age structure and tree density; 2) the frequency, abundance and distribution of both understory and overstory fire across the sampling range and, 3) the species and community-level effects of fire on the ecology of Kejimikujik's forests.

2.2.1 Age Structure

Sample stands were grouped into one of three age structure classes, single-cohort, double (tiered) cohort, and multiple-cohort. Although the age range within a cohort can vary considerably (Oliver and Larson 1990), ten years either side the mean is typical (Husch et al. 1982). Age-class structure was determined using the range of tree ages sampled from both canopy and subcanopy layers (Table 5). Canopy trees statistically (as determined using z-scores) found to be on average within $10 + (0.03(\text{mean}))$ years of the mean

Table 5. Matrix for determining the age structure of each sample stand. Each stand's age structure class was determined by indexing the evenness of its canopy and subcanopy layers and by comparing the difference between them.

Canopy Structure	Age difference between Canopy and Subcanopy layers	Stand Structure
Single-cohort	Indiscernible	Single cohort
Single-cohort	Discernible	Tiered - two cohort
Multiple-cohort	Indiscernible/Discernible	Multiple-cohort

age of sampled trees were considered part of the same cohort (0.03 years was considered the mean sampling error). Age differences between canopy and subcanopy layers were compared using a visual analysis of scatter plot data. Stand structure was interpreted using the matrix outlined in Table 5.

2.2.2 Relative density

Relative tree densities were determined for canopy, subcanopy, and understory layers using the number of stems found per hectare.

2.2.3 Point frequency time-since-fire analyses

A point frequency master fire chronology was derived from fire scar data, using methods outlined in Agee (1990). The chronology summarized the date of each fire, the time since fire, and the fire interval (or number of years between successive fire events). Fire intervals were

averaged both for each cross-section and among all cross-sections. As it is difficult to separate fire events less than four years apart, such data were excluded from all mean interval calculations (Arno and Sneek 1977). The point frequency fire analysis was used to summarize the history of understory fire in Kejimikujik.

2.2.4 Stand origin analyses

Age structure data was combined with the presence or absence of charcoal to identify sample stands of stand-replacing fire-origin. Single-cohort sample stands, having charcoal in their soil and or duff layers, were classified as having originated with stand-replacing fire. Such stands were marked in the GIS database; contiguous stands with canopy homogenates similar to within ten percent were assumed to have originated with the same fire. Canopy age data were used to date each respective fire. Polygon

boundaries were used to approximate fire size. Fire size and dates were used to determine the probability of any one stand burning in a given year and to index a fire cycle (Van Wagner's 1978) for the study area.

2.2.5 Fire effects

Fire's role in shaping Kejimikujik's forest system was interpreted using a community-level response analysis. The analysis was conducted under the assumption that Kejimikujik's current forests bear a representative record of both historical fire and its ecological effects. The approach was adapted from a similar procedure developed by Rowe (1983).

Rowe (1983) developed a scheme to classify tree species according to their response to disturbance events. In this study, the analysis was designed to compare the structure of burned stands with unburned stands. Structural differences were related to both the type and frequency of past fires and served as the basis for interpreting successional trends in fire shaped Acadian forests. Trends were related to adaptive traits in individual species (see Rowe's 1983) and

literature outlining post-fire communities in Nova Scotia (e.g. Fernow 1912, Martin 1956).

2.3 Archival survey

Historical records were reviewed to provide additional information on forest fires in Kejimikujik National Park, and to verify and or qualify field data. Findings at the local scale were compiled from village newspapers, taped interviews, the Kejimikujik Oral History Study (KOH) (Parks Canada 1977), reviews of park and provincial fire records, and other written records. This data provided cultural information on the historic role that fire and logging played in the lives of local residents and helped paint a 'forest picture' of the Kejimikujik landscape and its development. Swain (1998) and Worden (1997) collected, compiled, and documented most of the research contained herein.

2.4 Analysis of historical fire weather

Variability in fire behaviour is driven by three elements: fuel, weather and topography, weather having the strongest influence of the three (Agee 1993). As such, climatic variables such as

precipitation, temperature, and wind can be used to predict fire risk and behaviour. These predictive variables have been compiled in a generalized index called fire weather (Van Wagner 1974). An area's fire weather is a measure of climatic influence on its past fire events and a predictor of its future fires.

Kejimikujik's fire weather was calculated using meteorological data collected in Greenwood and Springfield, Nova Scotia. Fire weather trends were correlated with variability in ignition frequency over the past 70 years. This analysis was derived from research conducted by Ponamarenko (1998).

Meteorological data was required from May 1 to October 31 (the period *a priori* established as the fire season, based on park and provincial records). Data from two of Environment Canada's weather stations were subjectively deemed representative of the Kejimikujik system. Both stations are located in the western end of the Annapolis Valley, within a 100

kilometer radius of Kejimikujik. The Springfield station was closest to the park, providing temperature and 24 hour precipitation data from 1920 to 1994. The Greenwood station provided the wind speed, wind direction, relative humidity, precipitation and temperature data necessary for the calculation of fire danger indices in accordance with the *Canadian Fire Danger Rating System* (Van Wagner 1978) (see Table 6).

For the Springfield station, fire danger indices could not be calculated because relative humidity and wind data were not available. This station provided trends in average daily temperatures, 24 hour precipitation, periods of drought (days without rain) for periods of 7, 10, 15 and 18 days, as well as the distribution of the 10 wettest and 10 driest years from 1920-1994. In addition, the distribution of rainfall was examined using the average precipitation per year, the average number of rainy days per year, and the average number of rain events less than 2 millimeters in depth.

Table 6. Data sources used for weather analysis.

Station	Hourly wind speed	Daily noon relative humidity	Daily minimal temperature	Daily maximal temperature	Daily (24 hour) precipitation
Greenwood	1953-1994	1953-1994			
Springfield			1920-1994	1920-1994	1920-1994

For the Greenwood station, 24 hour precipitation, noon temperature, noon relative humidity, and noon wind speed were used to calculate the *Daily Severity Rating* (DSR). The DSR is a power function of the *Fire Weather Index*, which is used in the *Canadian Fire Danger Rating System* (Van Wagner, 1978). *Fire weather Pro* software (Remsoft 1996) was used to perform the necessary calculations. Trends in the Daily Severity Rating were analyzed from 1953-1994. For trend analysis we looked at all days over a DSR of 8 as being significant fire days.

Trend analysis was conducted using *Microsoft Excel* Software. Linear correlations and 2nd, 3rd and 5th initiations of three year running means were examined for all variables. Where definite breaks occurred in running means, duration was divided into periods and a mean and variance taken for each. T-tests

were used to determine if differences between periods were statistically significant.

The Nova Scotia Department of Natural Resources provided provincial forest fire records for the 1953-1994 period; data was used for comparison with the Greenwood weather data. The records contained numbers of fires and average fire size per year. These variables were used to correlate changes in fire weather with variation in fire danger indices.

3.0 Results and Discussion

3.1 Forest structure

Field data on forest structure consists of a description of stand overstory, understory, and ground strata. Each horizontal layer was characterized in terms of the abundance, density, age structure, and physiognomy (size and form) of component species, as applicable.

Although a complete description of the park's forest communities was available through Gimbarzevsky's (1975) ELC, structural data was collected as a means of:

- 1) obtaining statistics on individual stands of interest;
- 2) allowing for the identification of post-fire structural features occurring at scales finer and/or coarser than that of a forest stand;
- 3) characterizing forest structural diversity with variations in both underlying edaphic properties and historical disturbance regimes;
- 4) interpreting fire history data with an updated knowledge of present-day patterns of forest structure and;
- 5) validating data from both Gimbarzevsky's (1975) ELC and NSDNR's (1992) forest survey.

Included in the description is a quantitative outline of the type of fuels available to sustain forest fire in each stand type. The outline encompasses measures of deadwood and ground surface features, as they relate to fuel loading.

3.1.1 Overstory stratum

Field data were used to document deviations from the forest structural

parameters outlined in the park's 1972 ELC and NSDNR's 1992 biophysical (as drawn from GIS databases). Comparisons were drawn using variation in overstory composition as an index of overall forest structure. Stand composition was measured using mean percentage coverage values for dominant canopy trees (see Table 7).

Results indicate a relatively strong similarity between GIS and field data sets. Two observable differences were found, including a higher than expected degree of single species dominance and a slight divergence in co-dominant species composition (Table 7). The GIS database provided enough information to locate stands in the field, and compare relative coverage values for different forest associations, but fell short of presenting a highly accurate record of stand structure. Disparity between GIS and field data sets may be attributed in part to the time lag between their respective sampling schedules and their comparative inequity in sampling intensity.

Sample stands were on average more homogenous (Table 7) than the statistical

Table 7. Tabular comparison of stand structure between GIS and field data sources. Structure is indexed from observations of canopy composition (relative percent coverage) as averaged among sample replicates. Species acronyms are detailed in Appendix A. (na - not available)

Stand Type	Field Data			GIS Data			Source
	sp. 1 (%)	sp. 2 (%)	Sp. 3 (%)	sp. 1 (%)	sp. 2 (%)	sp. 3 (%)	
rS	rS (70)	rM (8)	bF (8)	S (90)	OS (10)	na	1992-NSDNR
wP	wP (96)	rM (4)	Na	wP (84)	S (15)	na	1992-NSDNR
rP	rP (92)	bS (6)	rS (2)	rP (68)	S (25)	OS (13)	1992-NSDNR
MS	rS (40)	bF (18)	He (16)	S (64)	IH (20)	OS (17)	1992-NSDNR
He	He (80)	rO (8)	He (6)	He (74)	OS (18)	na	1992-NSDNR
rO	rO (61)	rM (16)	wP (14)	rO (54)	IH (20)	wP (10)	1992-NSDNR
bS	bS (77)	rM (12)	La (8)	bS (>30)	na	na	1972-ELC
wB	wB (68)	wP (8)	sM (6)	wB (>30)	na	na	1972-ELC
rM	rM (58)	bF (12)	bS (6)	rM (>30)	na	na	1972-ELC

population as a whole (Table 4). This may be partly attributed to some bias introduced during field surveys. In searching for sample sites, data collectors were more likely to locate stands with better defined peripheries, those of single-species stands being the most obvious.

Stand density was measured using spherical densiometer estimates of crown cover. The densiometer incorporates tree number and dbh, through the crown diameter/dbh relationship, to index overstory density. The densiometer provides data analogous to calculations of stand basal area (Brack 1996). Overstory density estimates are outlined in section 3.3. In general, density differences amongst stand types were not large.

Hemlock, white pine, and white birch stands were the densest, black spruce and red spruce, the least.

Overstory structure was also described in terms of both the age and physiognomy of canopy (Table 8) and subcanopy trees (Table 9). Hemlock and the two pine species featured stands of, by far, the largest trees. Stands of these same three species were also amongst the oldest sampled, although age differences amongst stand types were narrower than similar differences drawn from comparisons of size (Table 8).

The age distribution of trees from both canopy and subcanopy layers was used to describe the age structure of each

Table 8. The age and physiognomy of canopy trees from each stand type is outlined; included (from left to right) is tree species richness (sp. Rich.), total tree height (Ht.), height to crown (Crn. Ht.), diameter at breast height (dbh, sampled at 1.3 meters) and mean age. (Species richness represents the number of different tree species sampled). Species acronyms are detailed in Appendix A.

Stand Type	Tree sp. Rich.	Ht. (m)	Crn. Ht. (m)	Dbh (cm)	Mean Age (yr)
bS	4	11±3	6±2	13.6±4.7	66±18
He	3	23±2	10±3	38.5±13.2	107±40
MS	10	19±4	9±3	27.7±10.7	69±27
rO	5	17±5	9±2	26.3±8.8	84±24
rM	4	15±6	5±4	22.8±11.5	67±30
rP	3	23±2	12±2	36.2±9.6	75±11
rS	2	14±4	7±2	15.3±8.5	61±23
wB	3	18±4	10±3	20.0±7.1	85±21
wP	2	26±3	13±2	40.4±10.1	92±37

stand as a whole. Tree age distributions were modeled against one of three patterns; the even-aged (single cohort), the multi-aged (multiple cohort), or the tiered (two cohort) age structure (see Table 5). The relative proportion of samples characterized by each pattern is indicated in Table 10. The age structure found for individual sample stands is outlined in

Appendix D. Few patterns are apparent from the age-structure data presented in Table 10. In general though, black spruce, hemlock, mixed softwood, red oak, and red maple forests appear to be dominated by multi-cohorts stands. This contrasts with the single and tiered age structures predominating in red pine and white birch stands.

Table 9. The age and physiognomy of subcanopy trees from each stand type is outlined; included (from left to right) is tree species richness (sp. Rich.), the dominant species (Dom. Sp.), total tree height (Ht.), height to crown (Crn. Ht.), diameter at breast height (dbh)(sampled at 1.3 meters) and mean age. (Species richness represents the number of different tree species sampled. Species acronyms are detailed in Appendix A.

Stand Type	Tree sp. Rich.	Dom. sp.	Ht. (m)	Crn.Ht. (m)	dbh (cm)	Mean Age (yrs)
bS	2	bS	4.9±1.8	3.0±1.3	5.8±2.6	52.1±18.5
He	1	He	9.5±3.0	5.3±2.4	13.2±5.8	95.7±77.0
MS	4	rS	9.6±2.9	4.4±1.8	9.9±3.0	39.3±16.2
rO	4	wP	9.2±3.7	4.3±2.4	10.5±4.1	40.2±19.2
rM	3	BF	5.0±2.7	2.0±1.0	7.3±2.7	41.0±17.5
rP	4	rS	6.2±2.4	5.2±9.8	7.6±2.8	62.5±48.9
rS	2	rS	5.7±2.2	3.3±2.1	6.8±1.6	50.7±18.3
wB	7	sM/He	6.9±3.6	3.4±2.5	8.9±5.2	57.7±20.4
wP	5	BF	9.3±5.0	5.3±3.3	10.4±3.7	46.7±17.0

Table 10. Ratio of sample stands showing single, tiered, and multiple age class structures. Species acronyms are detailed in Appendix A.

Age Structure	Stand Type								
	bS	He	MS	rO	rM	rP	rS	wB	wP
Single	0.2	0.0	0.2	0.0	0.4	0.6	0.4	0.5	0.2
Tiered	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.25	0.4
Multiple	0.6	1.0	0.8	1.0	0.6	0.0	0.4	0.25	0.4

3.1.2 Understory stratum

Understory structure was described in terms of the composition, density, and physiognomy of all plants two meters or less in height. Plants less than five centimeters in height, or 0.1 centimeters in diameter, were only keyed and counted.

Data were used to quantify stand recruitment (Appendix E, Table 11), describe understory composition (see section 3.3), and compare patterns of stand

replacement (see section 3.3). Stand recruitment was indexed using the absolute density of understory trees. Stand replacement projections were determined using indices of understory basal area (Husch et al. 1982).

Table 11. Density (stems/hectare) of regenerating tree species in the understory of different forest stands types of Kejimikujik National Park, rounded off to the closest thousand. Recruits were classified as tree species with heights of ≤ 2 meters. Species acronyms are detailed in Appendix A.

Regenerating Tree Species	Sample Stand Type								
	bS	He	MS	RO	rM	rP	rS	wB	wP
<i>Acer pensylvanicum</i> L.									15000
<i>Acer rubrum</i> L.	295000	51000	72500	172000	170000		261000	350000	113000
<i>Acer spicatum</i> Lam.						60000		5000	
<i>Abies balsamea</i> (L.) Mill.			20000	5000	20000		52500	252000	
<i>Amelanchier</i> spp.	35000					10000	55000		
<i>Corylus cornuta</i> Marsh.				5000					
<i>Fagus grandifolia</i> Ehrh.		5000						15000	
<i>Hamamelis virginiana</i> L.			5000	17500				55000	35000
<i>Nemopanthus mucronata</i> (L.) Trel.					5000				
<i>Picea glauca</i> (Moench) Voss		5000	35000	7500		20000		5000	10000
<i>Picea mariana</i> (Mill.) B.S.P.	32500				30000	35000		17500	
<i>Picea rubens</i> Sarg.			20000	5000		5000	25000		
<i>Pinus strobus</i> L.		5000	25000	188000	40000		67000	150000	564000
<i>Populus grandidentata</i> Michx.			5000						
<i>Prunus serotina</i> Ehrh.					5000				
<i>Quercus rubra</i> L.		5000		10000					5000
<i>Tsuga canadensis</i> (L.) Carr.		17500	40000						
<i>Viburnum cassinoides</i> L.							5000		

3.1.3 Ground stratum

The composition and relative dominance of shrub and herbaceous ground flora found in each stand type are outlined in section 3.3.

3.1.4 Forest fire fuels

All stands were surveyed for both the abundance, type, density, and level of decomposition of dead woody material. Measures of slope, drainage, and canopy closure were also taken. Data were used to gauge levels of fuel loading. Strong

($p < 0.05$) correlations existed between several indexed parameters. Increases in canopy closure were closely correlated with increased litter density ($r = 0.439, df = 43, 0.002 < p < 0.005$), decreased litter thickness ($r = 0.363, df = 43, 0.01 < p < 0.02$), and increased litter abundance (ground coverage) ($r = 0.347, df = 43, 0.01 < p < 0.02$). Sampling site slope appeared to have a strong influence on drainage ($r = 0.660, df = 43, p < 0.001$) but neither slope ($r = 0.01, df = 43, p > 0.5$) nor drainage ($r = 0.110, df = 43,$

0.5>p>0.2) was closely tied with deadwood decomposition. Canopy closure was not associated with site drainage ($r=0.095, df=43, p>0.5$). Table 12 outlines a summary of the parameters measured to index forest fire fuel loading and risk.

3.2 Fire history

3.2.1 Field data

Spatio-temporal distribution

The historic presence of fire in Kejimikujik was readily apparent. Charcoal was found in nine of ten sampling sites (87%), often

Table 12. Parameter summary of variables relevant to forest fire fuel loading. Included (from left to right, top to bottom) is an index of canopy closure and mortality; the type, compaction, and thickness of forest floor litter; drainage; whether live branches are touching the ground; the maximum height (centimeters) of herbs and shrubs and the height to live understory crown (cm); the abundance of litter, branch, and bole surface fuels and their level of decomposition (decmp). See Appendix C for details on the class system used to index each measure. See Appendix A for detailed outline of species acronyms used. (cm - centimeter)

Stand	Canopy		Forest floor			Drainage (index)
	Closure (%)	Mortality	Type	Composition	Thickness (cm)	
bS	90±3	0	Leaves	Loose	22±4	4.6±0.9
He	97±2	0	Needles	Compact	10±5	1.8±0.5
MS	91±8	0	Needles	Compact	10±3	2.8±0.5
rO	94±1	0	Leaves	Compact	6±2	2.2±0.5
rM	89±6	0	Leaves	Compact	16±5	4.0±2.0
rP	93±2	0	Needles	Compact	16±6	2.0±0.8
rS	90±3	0	Needles	Compact	21±9	4.0±1.2
wB	96±2	0	Leaves	Compact	3±2	1.6±0.9
wP	95±2	0	Needles	Compact	13±3	2.6±0.6

Stand	Ladder fuels			Surface fuels				
	branch to grnd.	herb/shrub height (cm)	ht. to live crown (cm)	litter (%)	branch (%)	boles (%)	Density (%)	Decmp.
bS	Yes	92±2	71±3	56±21	37±21	7±8	<25%	Intact
He	No	38±2	23±3	62±31	15±10	6±9	25-50%	Intact
MS	Yes	70±3	61±6	56±20	36±17	8±11	25-50%	Intact
rO	Yes	67±3	56±3	70±10	24±11	7±10	25-50%	Intact
rM	Yes	97±2	100±3	43±33	36±18	19±14	<25%	Intact
rP	Yes	58±4	29±2	85±6	12±10	2±5	<25%	Intact
rS	Yes	76±3	64±1	54±22	41±24	5±5	<25%	Intact
wB	Yes	60±4	78±6	71±6	26±6	3±4	<25%	Intact
wP	Yes	55±3	83±4	76±9	20±7	4±5	<25%	Intact

in abundance. Many trees of varied age and taxa were encountered with basal fire scars. Scars were occasionally cryptic and or had anomalous morphologies, tending to belie their chronicle of sometimes multiple fire events. Typical, and more easily recognized, burn remnants such as bark seams, cat-faced cambium scars, charred deadwood, scorched roots, ash mottled soil horizons, and charcoal flecked duff strata were also found throughout.

Evidence of both high and low intensity fire was found across the study area. Kejimikujik has experienced a mixed severity fire regime, both types of fire having played significant roles in its history. In some instances such fires have occurred together in space, elsewhere in isolation. The spatial and temporal distribution of historical fire across Kejimikujik is depicted in Figure 7. Appendix M summarizes all known fires in the Kejimikujik region.

Although there appears to be a spatial correlation between burn sites and the occurrence of roads, this is likely an artifact of sampling bias. In other words, these fire's proximity to roads does not suggest they all started through human ignition. Every effort was made to ensure the random distribution of sampling sites, across the study area, as practical (see section 2.1.3).

Within the period of record, the majority of fires occurred before the park's establishment (1964). In fact, all crown fires and 76% of surface fires occurred before 1960. Figure 8 outlines changes in fire frequency over the past two hundred years. Fire's frequency began its steady ascent in the last third of the nineteenth century, the growth trend continuing rapidly to peak just before 1960. The years that followed showed a marked decrease in fire frequency, a trend that has continued until present day. This pattern of ignition might be

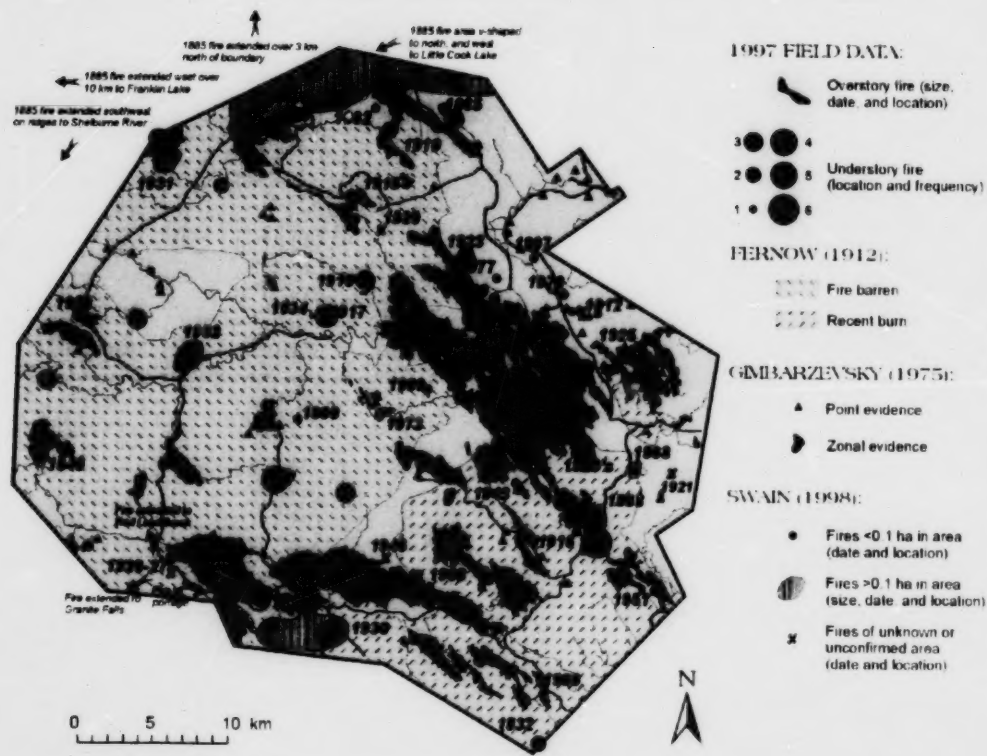


Figure 7. The spatial and temporal distribution of both historical overstory and understory fires across Kejimikujik National Park. Included with data collected for this study are field and archival observations drawn from Fernow (1912), Gimbarzevsky (1975), and Swain (1998). Fires taken from Swain (1998) only include those documented in national park records.

closely predicted considering many consequential events in the area's colonial history.

The middle of the nineteenth century marked a sharp rise in European settlement throughout the Kejimikujik region. Many of the new settlers, some of them seasonal, came to utilize the area's timber resources. Such forest harvest activities may have sparked blazes in previously inaccessible

and or unsettled areas, contributing to an overall regional increase in ignition frequency. This increase may also reflect the use of fire in the renewal of colonial hay fields and blueberry barrens (Johnson 1986).

As population levels continued to expand with the turn of the century, the demand for wood products grew, driving up their market value, dramatically increasing

logging activities, and subsequently perpetuating a mounting surge in the number of anthropogenic ignitions (Johnson 1986). In 1904, Nova Scotia responded with the implementation of its first provincial forest protection act (Lands and Forests Act), designed to better safeguard the province's people, property, and timbers from errant blazes. The result was two fold. Logging continued to increase forest fire frequency, control efforts serving to decrease the size of each burn (Johnson 1986). In Kejimikujik, available accounts from 1885-2000

indicate the largest known fires occurred before 1960. Since the advent of modern fire control techniques in the early nineteen-sixties, very few provincial fires have exceeded twenty hectares in size (Wein 1977).

As shown below, the distribution of known fire events throughout the last two hundred years of Kejimikujik's past can be readily shown to mirror the pattern of occurrences in the area's colonial history. However, a source of bias lies in the data. Much of the data was derived using point

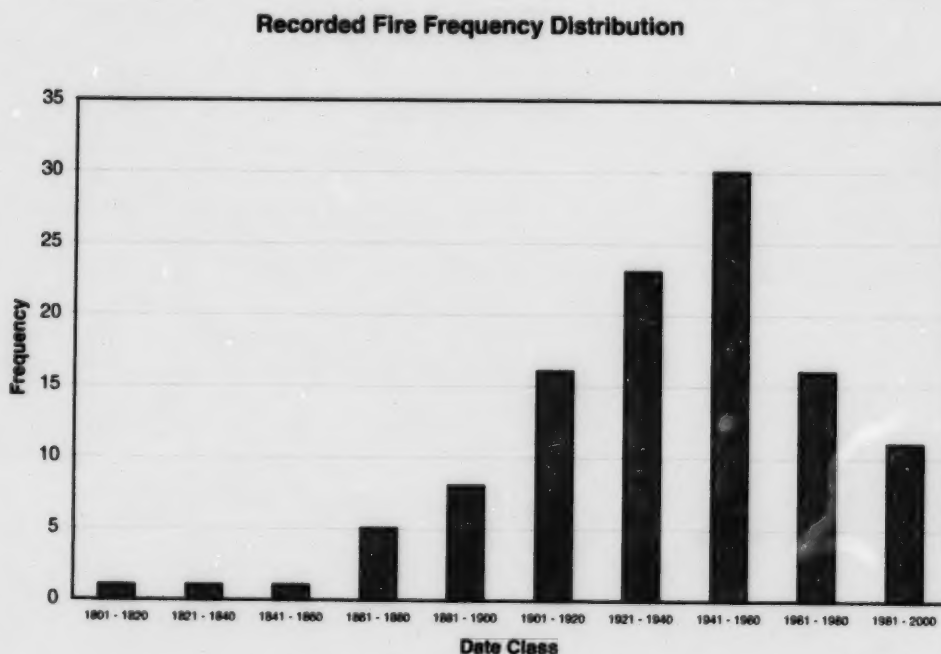


Figure 8. Temporal trends in fire frequency from 1801 - 2000 in Kejimikujik National Park as indicated by field data.

frequency statistics drawn from basal cross-sections. The age of these cross sections was biased towards younger trees, these trees being the most abundant. As such, fires occurring in the more distant past were less likely to appear in the historical record. This bias has likely served to skew the distribution charted in Figure 8 towards the twentieth century.

Understory fire

We found evidence of understory fire dating as far back as 1803, or 194 years before present. Over this period 113 fires were chronicled. Although single trees provided evidence of upwards of six fires, most sampled basal cross-sections only showed one to three burn annuli.

Sampling was biased towards stems providing the most data, those being the oldest multiple-scarred trees (with breast height diameters ≤ 70 cm, a size cap imposed by the park). Scarred samples were not taken from stand peripheries, or from groups of noticeably older trees found embedded within a given stand, as such scars are typically left after stand replacing fire.

It was not uncommon to find scarred trees in clusters, all stems scarred at the same aspect and height, sometimes grouped together over an area of several hectares. The majority of fire scars were isolated on single trees or small groups of trees in red oak, white pine, and hemlock stands. Table 13 documents the frequency with which historical understory fire was encountered in different sample stand types. Figure 9 outlines the spatial distribution of historical understory fire across Kejimikujik, as predicted by sample data. Appendix M summarizes all known understory fires in the Kejimikujik region.

Understory fire frequencies were reported for single points, or loci, in space, namely where a tree, or several proximate trees, showing evidence of multiple fire events were found (Agee 1993). As it was difficult to determine the areal extent of individual burns, point frequency data were used to describe the effects of multiple fire events over an unspecified area about each loci. In this study, trees from other stands were not considered close enough to reveal evidence from individual fires. Similarly, the effects of

Table 13. Outlined is the proportion of samples, of each sample stand type, showing a history of understory fire. See Appendix A for outline of acronyms.

	Stand Type								
	rS	wP	rP	MS	He	rO	wB	bS	rM
Proportion	0.2	0.8	0.6	0.2	1.0	0.4	0.8	0.2	0.8

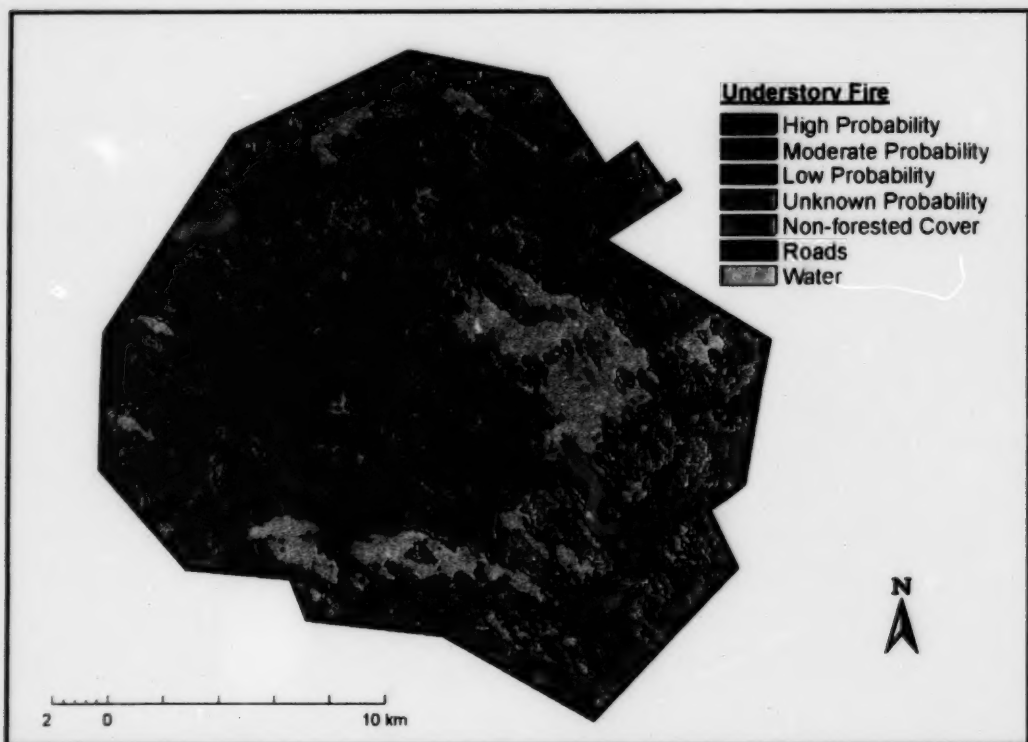


Figure 9. The predicted spatial distribution and abundance of historical understory fire across Kejimikujik. Field data was used to outline fire's high, moderate, or low probability of having occurred in different stand types across the park. Probability estimates were based on the proportion of samples, of each stand type, where historical fire was detected. Stand types showing a 0-39% sampling incidence of understory fire were subjectively grouped into the low probability class, a 40-59% sampling incidence as moderate, and a 60-100% sampling incidence as high.

each fire were not described outside stand boundaries. Frequency data was used to

compare the relative effects of multiple fires amongst sampling loci.

Point frequency data are summarized in a master fire chronology (Table 14).

Included is the time elapsed since each historical fire, the return interval (in years) between fires, and the mean return interval for each sample. Intervals ≤ 3 years (marked with *) were not included in mean fire interval calculations (see Arno and Sneck 1977). In this study, historical fire data from individual trees of the same stand were not grouped.

The effect Kejimikujik's historical understory fire regime has had on its forest communities is discussed in Section 3.3.

In general, understory fire return intervals were shorter than expected, on average 25 ± 17 years. The shortest return intervals were found for red oak (12.7 years), red pine (19.7 years), white pine (21.7 years), and white birch (23.8 years) stands, the longest for red maple (31.4 years), black spruce (27 years), and hemlock (26.1 years) stands.

Overstory fire

Overstory fires comprised 13% of Kejimikujik's historical ignitions. These fires were

also relatively small, on average only 11 hectares in size (see Figure 7). Strong evidence revealed overstory fire gave rise to thirty-seven percent of sampled stands. As samples were drawn from a subset of all stands in the statistical population, or an area equivalent to 25% of the park's forests, overstory fire can be said to have had a significant role in the origin of 9%, or 27 square kilometers of Kejimikujik's forests. Figure 10 outlines the spatial distribution of historical overstory fire across Kejimikujik. Appendix M summarizes all known overstory fires in the Kejimikujik region.

Van Wagner's (1978) fire cycle index was used to determine the average overstory fire return interval for an area equal to that covered in the study. Based on the available fire history, overstory fires have a 1.2 in 100 chance of occurring in a given year. This computes to a historic overstory fire cycle of 78 years or 67.6 hectares burned every ten years. The return interval found for other-origin sites is very similar at 77 years. It could be argued that Kejimikujik's other-origin sites are all of post-logging origin, the park's post-fire

Table 14. Master understory fire chronology. Included is the identification code given to each basal cross-section. The code breaks down as the: stand type/replicate# - cross section #. Also included is the species and age of each sampled tree, the time elapsed (in years) since each historical fire, the return interval (in years) between successive fires, and the mean return interval (in years) for each sample. See Appendix A for list of tree species acronyms. x.s - cross-section.

x.s.	sp.	Age	Time Since Fire						Fire Interval					
			1	2	3	4	5	6	1-2	2-3	3-4	4-5	5-6	Mean
bS5-1	wP	54	47	20					27					27.0
BURN1-1	rP	71	54											
BURN2-2	rO	?	127	19	7				108	12				60.0
BURN3-1	rO	?	72	29	25				43	4				23.5
BURN3-2	wP	72	66	59	53	47	8		5	5	6	29		11.3
He1-1	He	159	125	43	25	6			82	18	19			39.6
He1-2	He	121	88	24	17	14	4		64	7	3*	10		27.0
He2-1	rS	123	77	69					8					8.0
He2-2	He	224	53	46	33				7	13				10.0
He2-C	He	?	108	94	35				14	59				36.5
He3-1	He	105	56	49	40				7	9				8.0
He4-1	He	101	16											
He4-2	wP	?	41											
He5-2	He	275	158	63	51				95	12				53.5
He5-C	He	85	51											
MS5-1	La	?	37											
rO3-1	rO	103	58	53	48	43	41	35	5	5	5	2*	6	5.3
rO3-2	lrA	?	39	19					20					20.0
rO4-1	wB	?	51											
rO4-2	rO	100	72											
rM2-1	La	138	96	39	12				57	27				42.0
rM2-2	rM	?	95	58	26				37	32				34.5
rM3-1	wP	?	72	61	42				11	19				15.0
rM4-1	rP	203	194	131	78	67			63	53	11			42.3
rM4-2	wP	122	79	76	41	12	7		3*	35	29	5		23.0
rP1-1	wP	83	58	20					38					38.0
rP1-2	rP	180	84											
rP4-2	rP	167	120	113	102				7	11				9.0
rP5-1	rP	?	96	79	66	60			17	13	6			12.0
rS3-1	La	?	63											
wB1-1	wB	59	45	40	16	12			5	24	4			16.5
wB1-2	sM	122	112	108	58				4	50				27.0
wB2-1	Be	?	85	41	35	14			44	6	21			35.5
wB2-2	He	?	31	15					16					16.0
wB3-1	wB	?	48											
wP1-1	rO	56	34	9					25					25.0
wP1-2	wB	93	47	45	32	29			2*	13	3*			13.0
wP3-1	wP	93	86	64					22					22.0
wP4-1	wP	?	98	69					29					29.0
wP4-2	wP	147	125	99	78				26	21				23.5
wP5-1	wP	?	49	21	14				28	7				17.5
wP5-2	wP	?	98	70					28					28.0

forests left undisturbed as they offered scarce resources. Table 15 documents the frequency with which historical overstory fire was encountered in different sample

stand types across the park. The majority of the park's overstory fires occurred in areas that are now dominated by white pine, white birch, and red pine.

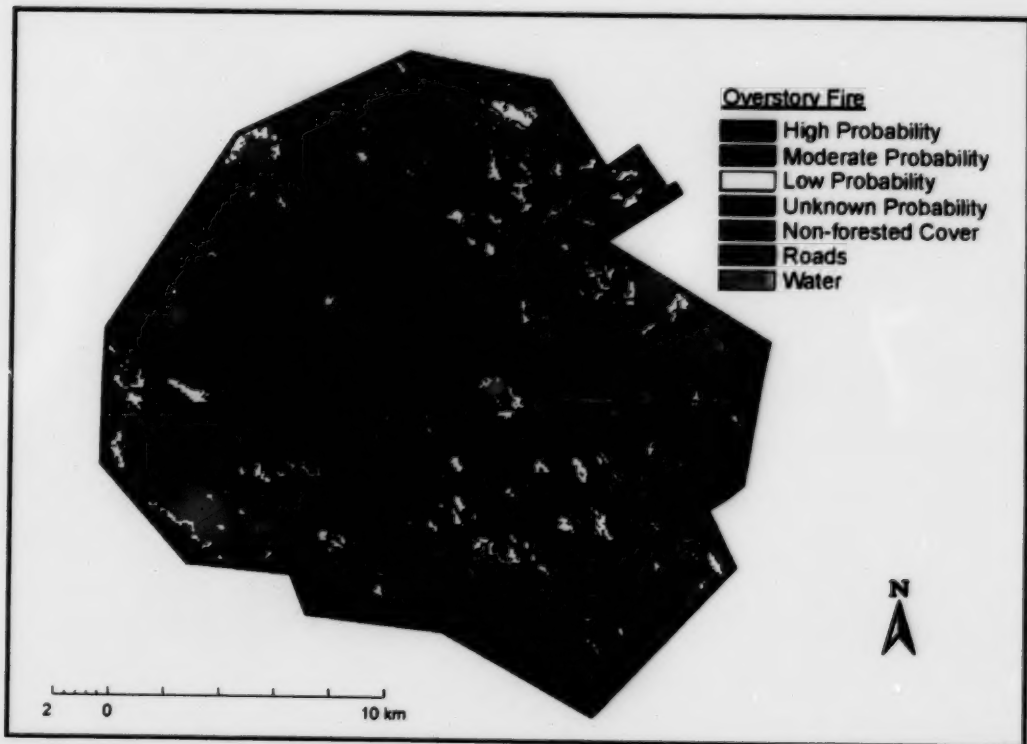


Figure 10. The predicted spatial distribution and abundance of historical overstory fire across Kejimikujik. Field data was used to outline fire's high, moderate, or low probability of having occurred in different stand types across the park. Probability estimates were based on the proportion of samples, of each stand type, where historical fire was detected. Stand types showing a 0-39% sampling incidence of overstory fire were subjectively grouped into the low probability class, a 40-59% sampling incidence as moderate, and a 60-100% sampling incidence as high.

Table 15. Outlined is the proportion of samples, of each stand type, showing a history of overstory fire. See Appendix A for outline of acronyms.. See Appendix A for outline of species acronyms.

	rS	wP	rP	MS	He	rO	wB	bS	rM
Proportion	0.4	0.6	1.0	0.0	0.0	0.0	0.6	0.4	0.4

3.3 Archival data

3.3.1 Human history

Geographic context

Kejimikujik National Park is located in southwestern Nova Scotia, straddling Annapolis, Queens, and Digby counties. Nearby communities include Caledonia, Kempt, South Brookfield, New Grafton, Harmony, and Maitland Bridge. The park is just North of Lake Rossignol, the province's largest freshwater body and an important logistic component of the local logging industry. Logging in and around Liverpool, a coastal town south of the park, is the primary basis for the area's economy. North of the park, lies historic Annapolis Royal (formerly Port Royal) on the province's Fundy shore. Figure 1 (section 1.0) outlines many of the geographic features addressed within this archival survey.

Pre-European contact

Prior to permanent settlement by Europeans in 1604, fire's influence was limited to the occurrence of lightning and aboriginal fires. The relationship aboriginal peoples had with fire is disputed in the literature. Many believe fire was extensively used as a means of clearing

land, improving berry production, increasing browse for herbivorous wildlife, and possibly for herding large game (Pyne 1982). In the continental Northeast, historical evidence suggests fire was seldom used other than for cooking, heat, and possibly as a smoke signal (Russel 1983).

The Mi'kmaq, the band of natives occupying Nova Scotia and vicinity, were a semi-nomadic people moving from camp to camp with the rise and fall of food sources (Hayward 1976, Morrison and Friend 1982) and the change of season. Typically, family groups would congregate on the seashores in summer, moving inland for the winter months (Speck 1922, Erskine 1962). Hunting grounds were loosely divided according to family rites, the centre of each territory usually a large water body (Speck 1922).

Little evidence is available to suggest the Mi'kmaq used fire outside their encampments, as did many less nomadic southern bands (see Russel 1982). Early writings indicate the Mi'kmaq depended primarily on marine and freshwater food resources, less so on the forests (see

Dickason 1993 for review). McLeod (1903) maintains the natives were particularly prudent with fire, never allowing its spread outside their campsites.

Early written accounts

The earliest records come from the French who landed at Port Royal to establish North America's first permanent settlement. Lescarbot (1606) wrote a description of New France, or Acadia as it was called, during his brief stay at Port Royal. Unfortunately, Lescarbot showed little interest in the forests, commenting neither on their structure nor on the occurrence of fire within them.

During French domination, approximately 100 Jesuit missionaries were sent to work among the Mi'kmaq of Acadia (Campbell 1921, Walsh 1934, Kennedy 1950).

Jesuits often wrote extensive letters to their counterparts abroad, describing the lives they were leading and the lands within which they worked. Many of the letters contained valuable observations on natural history. "No coureur de bois was more expert in forest lore than were the Jesuit Fathers; and the records made by these soldiers of the cross are of the highest scientific value" (Thwaites 1896). The Canadian missions were instated on

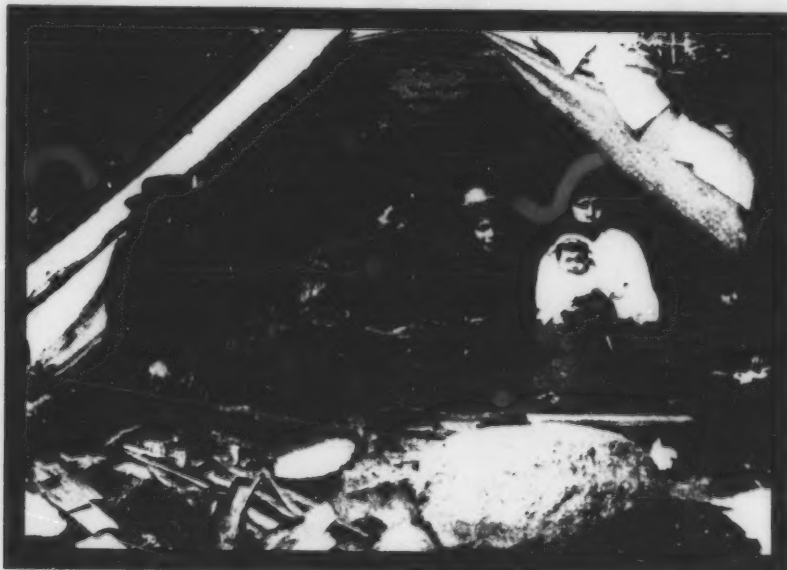


Figure 11. Mi'kmaq encampment, Queens Co., NS (taken from McLeod 1903)

June 12, 1611 when two Jesuit fathers, Pierre Biard and Ennemond Masse landed at Port Royal to begin their work among the Mi'kmaq people.

The few existing Jesuit records of precolonial fire are unsubstantial and anecdotal. No information exists to describe fire in the Kejimikujik area. However, as the following sample excerpt attests, large fires did occur in Acadia:

"...quelquefois ce feu alloit jusqu'a trois lunes. Ce feu qui avait dure jusqu'a trois lunes revolves, nous devenoit un feu sacre et mysterieux. Nous dansions alors autour de ce feu et voyci ce que nous proferions et chantant:

"Allume, O feu, nos callumets, et fais qu'en pompant ta vertu sous l'enveloppe de la fumee qui te cache a nos yeux...et conserve-toy pour toujours dans nos coeurs..."(Maillard 1863)

The passage is selected from a letter Pierre-Antoine-Simon Maillard wrote

during his 1641 mission among the Mi'kmaqs. It roughly translates as Maillard's observation of how the natives were responding to a particular fire in the area. According to Maillard, the Mi'kmaq periodically danced and chanted about a fire lasting three months. From this we learn that likely extensive fires occurred in the region and that the Mi'kmaq likely held a comfortable familiarity with them. Nothing is gleaned about the fire's ignition source, its utilitarian value in the native culture, or its influence on surrounding forests.

Nicholas Denys (1598-1688) provides the best description, indeed most of the information we have, of Nova Scotia's forests in the seventeenth century. The precolonial forests Denys encountered were generally larger and older than the forests that now occur in the province. Although spruce budworm and other endemic insects likely had as strong an influence on historic forests as they do today, fire appears to have been the dominant disturbance force. During his period of exploration, Denys encountered evidence of some very large lightning fires, some upwards of 10 - 15 leagues (75

to 120 square kilometers) (Denys 1672). If Denys (1672) writings are any indication, forest fire was relatively common in precolonial southwestern Nova Scotia. While Denys initially surveyed around Port Royal and later La Have, he did not describe the western interior of the province.

In 1686, the first European traveled through the area which is now Kejimikujik National Park. Jacques de Meulles, Intendent of Canada, traveled from Nova Scotia's Fundy coast to its southern shore, utilizing the series of waterways and portages frequented by natives and later so many other European colonists. Meulles wrote an account of his trip (Morse 1935) but unfortunately made no reference to the forests or to fire, being somewhat preoccupied by the difficulties and terrors of a canoe trip through "very dangerous rapids, full of great boulders and rocks, and of extraordinary length." Figure 12, below, a 1842 engraving from *Canadian Scenery Illustrated*, shows the General's Bridge near Annapolis Royal. The artist comments on the natives camped in the foreground indicating their preparation for a journey through a series of waterways

across the province (as taken from DeVolpi 1974).

In the eighteenth century, most of Nova Scotia's settlements dotted its coastal shores. Liverpool, one of the largest villages, was reported to have about 100 resident families by 1762. During the period, a Liverpool merchant, Simeon Perkins, kept a diary from which we have accounts of forest fires in Queens County. For instance, he reports many fires in all quarters around Liverpool in June and July 1792, with nothing done to stop them. He also records heavy smoke over Liverpool all through the summer of 1800, the result of a big fire which burned most of the land south of Jordan Lake and Lake Rossignol from the Roseway River to the Mersey River. Within close proximity, Johnson (1975) reports over 90,000 acres between Lake Rossignol and Medway River burned in a fire reported several decades earlier in 1720.

By the end of the eighteenth century, Nova Scotia's string of coastal settlements were quickly depleting all seaside forests. More and more, colonists had to journey inland for wood. This led to the settlement of the

interior of Nova Scotia. In Queens County the area was called *The Northern District*.

William Burke was the Northern District's first settler, establishing himself in, what is now, South Brookfield in 1799. Two years later he was visited by Titus Smith Junior. Smith had been commissioned by Lieutenant-Governor John Wentworth to conduct a resource survey of the province. The information would be used to help establish certain naval stores and to determine which areas would be suitable for growing hemp. Smith (1802) describes three journeys into the interior of the province in his report, *A Natural Resources Survey of Nova Scotia: 1801-*

02. The report is a fascinating account of Smith's travels and shows him to be a pioneer in plant ecology well over a century before the term was coined.

Smith observed a huge area of young hardwoods a few miles distant from Burke's land. The area was approximately 50 kilometers by 30 kilometers and extended from several kilometers east of Lake Rossignol to Middle River, Lunenburg County. According to Smith, Burke had learned from natives living nearby that the trees here had all been blown down by a hurricane 80 years earlier and had burned in a large fire the following year. Smith notes that he is



Figure 12. Near Annapolis Royal, NS (taken from DeVolpi 1974)

inclined to believe this account since there were large areas covered with young beech, hard maple, white ash and hornbeam. Smith repeatedly mentions barrens within the body of his report. Using Smith's writings, Johnson (1986) estimates that over one million acres of forest probably burned from 1791 to 1800. This added to the 1,300,000 plus acres of fire barren left from the province's earlier burns.

Soon after Burke established himself at South Brookfield, other settlements followed. The first house in Caledonia was built in 1817. Harmony, Kempt and New Grafton were settled in 1821. Land was cleared, farming began, the settlements grew and lumbering started in earnest.

By 1760, Nova Scotia had begun the rapid extraction of its forest resources (Goldsmith 1980). Goldsmith speculates that between 1760 and 1860, New World colonists drastically changed the face of the province's forest landscape. Timber was exported at a phenomenal rate; by 1861 Nova Scotia employed 1401

sawmills, a number never exceeded to this day.

Goldsmith (1980) suggests records written before 1760 give us the best representation of Nova Scotia's precolonial Acadian forest. As the southwestern interior was only settled in 1799, reports predating this date likely provide an accurate representation of Kejimikujik's precolonial forest structure and composition.

During the nineteenth century, the frequency of anthropogenic fire rose higher and more quickly than ever before. Logging and land clearing often sparked fires too large for existing technology to extinguish. More often, errant fires were abandoned for they rarely threatened the settlers or timber resources in a land as expansive and productive as the southwestern interior.

Johnson (1986) reviewed the diary of Sylvanus Morton, a resident local to the area just south of Kejimikujik. Morton reports the spring of 1860 as being a dry time of "great raging fires and great damage to timberlands". September of 1865 was another dry period with the

woods in Queens County "all on fire". At the time in Annapolis county, Calnek and Savary (1897) reports the occurrence of large thunderstorms in June of 1891 and 1892 "causing great fires and much damage to the forests".

In 1869 Captain Hardy wrote a detailed paper describing the forests of Acadia. Hardy notes the occurrence of fire barrens in his travels throughout the region. The barrens, he reports, "extend for many miles, and are most dreary in their appearance and painfully tedious to walk through."

Late in the nineteenth century, the abundance of fish and game began to attract sportsmen to the Kejimikujik area. One might be forgiven for believing that these sportsmen were attracted by the prospect of hunting and fishing in a pristine environment, "far removed from the haunts of men." But the wilderness they found may not have lived up to the scene pictured in their minds' eye before the trip. The following description, from Albert Bigelow Paine's popular turn of the century book *The Tent Dwellers* (an account of a fishing trip through the

Kejimikujik area about 1906) reveals something of the extent of fires in the area:

"... My trip on the train along the coast, and the drive through farming country, more or less fertile, had given me little conception of this sinister land – rockstrewn and barren, seared by a hundred forest fires. Whatever of green timber still stands is likely to be little more than brush. Above it rise the bare, gaunt skeletons of dead forests, bleached with age, yet blackened by the tongues of flame that burned out the life and wealth of a land which is now little more than waste and desolation..." (Paine 1908)

From the writings, it is apparent this could have applied to a good deal of the country he traveled through. Paine attributes the majority of these fires to the carelessness of local lumbering operations.

In 1908, the year *The Tent Dwellers* was published, the Lumbermen's Association of Western Nova Scotia pressed for a survey of the province's forest resources. As a result, Dr. B. E. Fernow, Dean of the School of Forestry at the University of Toronto, was commissioned for the task.



Figure 13. *Little River, Annapolis Co., NS (Paul Yates, ca. 1910, Parks Canada collection)*

Field work was carried out over two summers by Fernow and his two assistants. Fernow published *Forest Conditions of Nova Scotia* in 1912.

Fernow estimated that over 2,500,000 acres (1,011,718 hectares) of mainland Nova Scotia had been burned by fire. Of this, more than 500,000 acres (202,344 hectares) had resulted from recent burns, the remainder a series of barrens very likely created by the actions of repeated blazes. Fernow reports the region of Queens County from Liverpool up the Mersey River to Lake Rossignol had been

made semi-barren by fire. He adds that forests from Screecher Bay on Lake Rossignol northward along the shore and all the way into Annapolis County had been destroyed by fire. This would include a large proportion of the present national park. Appendix G shows most of the Annapolis County portion of Kejimikujik as *barrens*, while a good deal of the area of the park in Queens County is delineated as (recent) *fires*. It's little wonder that Albert Bigelow Paine commented on the extent of the destruction by fire in *The Tent Dwellers*.



*Figure 14. Fire barren, Queens Co., NS; burned in 1878
(taken from Fernow 1912)*

Nova Scotia's first act of legislation concerning the prevention of forest fires was implemented in 1761, after the founding of Halifax, and entitled "An act for preventing dangers by unseasonable burning, or firing of the woods". Minor changes to this Act were made in 1864 and 1873. In 1884, the legislation was revised giving the Department of Crown Lands authority to enforce all regulations. In 1904, significant changes were made when the Department of Crown Land and the Department of Game were joined under one Department of Lands and Forests; with new authority, the Department implemented the Lands and Forests Act,

consolidating and unifying municipal fire fighting districts (Creighton 1969).

Despite new legislation, and growing concern over the hazards of forest fire, the first fifty to sixty years of the twentieth century saw more fires than ever before recorded. In 1912, Dr. C. D. Howe reported "over a half million acres recent burns in Nova Scotia, on which the reestablishment of timber trees is at a standstill and will be for many years, even if future fires are excluded" (Johnson 1986). From 1900 to 1914, more timber was lost to fire, disease and storms than was harvested (Johnson 1986). From 1915 to 1927, 1673 fires burned over 307,542

acres (125,000 hectares); from 1931 to 1945, 4,895 forest fires burned 251,183 acres (102,000 hectares), a mean 326 fires per year, each 51.4 acres (20.8 hectares) in area (Canadian Institute of Forestry 1959). By the nineteen-sixties improved technology allowed for far better prevention and control measures forcing a significant drop in fire size and frequency.

Newspaper Accounts

The Gold Hunter and Farmers Journal was a local newspaper published in Caledonia from 1888 until 1941 when the newspaper building was destroyed by fire. Microfilm copies of existing *Gold Hunters*, from the collection of the North Queens Historical Society, were examined for reference to forest fires. Unfortunately the collection is far from complete. The earliest available copies of the newspaper date from 1892; there are many copies missing from subsequent years. Fires in which buildings, sawn logs, or lumber were destroyed or threatened were more apt to be reported than a fire that simply destroyed forest. A list of all references to fires found in the *Gold Hunter* is found in Appendix H.

Only three fires within the present Kejimikujik National Park were reported in available copies of the newspaper. On May 19, 1916, a fire was reported which burned down the east side of the Mersey River from the eel weir (just North of Loon Lake in the park) as far as Christopher Lake. This was worthy of mention because a sporting camp at Lowe's Landing on Lake Rossignol was threatened. The September 19, 1921 issue of the paper reported on a fire which burned the buildings at the McClair(sic)-Ford Mine, forcing the miners to flee. On August 23, 1929, while reporting on a number of active fires in the province, mention is made of one at Channel Lake. Park archives indicate a very large fire burned in the northern part of Kejimikujik (see Figure 7, section 3.2.1) in 1885. To learn more about the fire, the Annapolis Royal Historic Restoration Society was contacted for copies of *The Spectator*, Annapolis Royal's weekly newspaper since 1882. There were no copies from 1885 in Annapolis Royal, but microfilm copies dating from 1884 are held at the Public Archives of Nova Scotia. A search of the available papers for the year 1885



Figure 15. *The Gold Hunter building, Caledonia, NS, ca. 1930*
(taken from Morrison and Friend 1981)

revealed no reports of forest fires. However, *The Spectator* was not available for the months of June through September. The year previous, and a few years following, revealed no references to forest fires. Fernow (1912) had written about a large forest fire in Annapolis County in 1903; unfortunately only the January issue of the *Spectator* was available for that entire year. The Public Archives of Nova Scotia added little to this research.

Oral Histories and Fire Records

Swain (1998) conducted oral history research as a means of painting a forest picture of past conditions in the Kejimikujik area. Loggers, fire fighters, and local residents were interviewed to

add to existing oral history data. Much of the information is qualitative, lending only narrative depth to data from other surveys. In some cases however, people's recollections served as cross-reference points, allowing for the verification and qualification of data from field surveys, provincial and national park fire records.

In 1977, Dr. James Morrison interviewed many local residents to gather material for his study *"We Have Held Our Own": The Western Interior of Nova Scotia, 1800-1940*. A number of the informants commented on forest fires. Swain (1998) drew this information from Morrison's (1978) document *Precis of Oral History Tapes*, as it's found in Kejimikujik's

archives. Appendix I gives a personal profile of each interviewed resident having provided information useful to this project. These residents include Leona Smith, Eric Millard, and Rev. A.G. McLare.

Rick Swain (1998) added to oral history data collected by KNP interpreters Peter Hope and Millie Evans through a series of interviews conducted for this project. These interviews were held with two locals, Allen Rowter and Willis Forrest. A personal profile of both Mr. Rowter and Mr. Forrest is given in Appendix I. Much of the oral history data Swain compiled is anecdotal. As such its presented here as a series of brief accounts:

Eric Millard (KOH 81 and KOH 102) related that there were many woods fires from 1860 to 1900. He read about them in surveyors' diaries written at the time. Millard described the extent of a large fire in the Frozen Ocean (in and North of KNP) area. He said it burned from Frozen Ocean north to Franklin Lake in Annapolis County (actually Digby County) and down along ridges as far as the Shelburne River and into Shelburne County.

Leona Smith (KOH 41) indicated the 1930's were a terrible time for fires. By the 1940's however, the situation had improved greatly. Ms. Smith recalls April as being the worst month for fire. Ms. Smith felt that many fires originated from people burning to improve blueberry production. Allen Rowter suggested the practice usually took place towards Shelburne but not in the park because of its inaccessibility.

Eric Millard said that woods fires were often caused by farmers burning meadow hay in April or October. Fires were started and left to burn until rain put them out. Allen Rowter agreed that meadows were burned, both to encourage growth of hay and to stop the encroachment of shrubs and trees. He recalled that the meadows on Cashman (Atkins) Meadow Brook were burned but the fires didn't get out of control. He did not know of any forest fires resulting from such burning. He did suggest that meadows in many areas of the park were used for hay, including around Kejimikujik Lake, the Mersey River, Mount Tom Brook and West River. The round trip to the upper meadows on West River took two days. Allen suggested it

was a lot of work for a return of poor quality feed. He relates that the woods must have been much more open (similar to descriptions of other areas in the nineteen-thirties) at the time to allow such travel.

While Willis did not know of any fires resulting from the burning of meadows, he did identify a fire that resulted from a haying operation. When he was logging at the south end of Kejimikujik Lake in the 1950's, all the pine near Cape Split was fire-scarred, a result of a campfire lit by people cutting hay on Snake Lake Bog.

Willis was questioned about fires engendered from steam mills sparks. He said that that rarely, if ever, happened. Those mills had high smokestacks with several layers of screen to catch sparks. In addition, the operation of such mills was pretty labour-intensive so there were lots of people there to bring a fire under control quickly.

Willis also reports that he didn't know of fires starting from the burning of slash. Trees were selectively cut so there wasn't the volume of slash you get with today's operations. When he was young anything under 8 or 9 inches diameter was left uncut.

When Willis worked for the Mersey Company in the nineteen-thirties, labourers were cutting spruce, fir and hemlock for pulp. The large pines in the area had to be cut as well. Many of these trees contained more than 1000 board feet of lumber, and, using a cross-cut saw, it took over an hour and a half to fell one. The pines were left where they fell. The company didn't want to let them stand because it was concerned about lightning. Willis feels there are more fires caused by lightning today than there were in earlier times. Allen suggested that the fire south of Dennis Boot Lake (see Figure 7, section 3.2.1, dated 1931) may have been the



*Figure 16. Meadow haying, Kejimikujik Lake, ca. 1915
(taken from Morrison and Friend 1981)*

result of a lightning strike because there was no logging or other activity in the vicinity at that time.

Allen said that fires sometimes started from log drives. The cook would have to prepare three or four meals a day, on the move, and each required a fire. The crew was in a hurry and didn't worry about putting the fires out since generally in the spring of the year this wasn't a problem. Occasionally a fire that was left unattended got out of hand. Allen said that even in the 1950's when they were driving logs out of Frozen Ocean they didn't worry

much about the fires. He quickly added that none got away from them. In the summer they were much more careful with fire.

Allen suggested that the 1885 fire in the north of the park (see Figure 7, section 3.2.1) may have been started by a crew driving logs down Torment Brook. Lan (Orlando) Ford and Simon Merry of Maitland Bridge were involved in that cut and the time they were there corresponds to the date recorded for that fire.

Willis Forrest, in talking about a fire near Peskawa about 1926, said that it wouldn't have spread so far if people had gotten there sooner, but "people were in no rare and tear to get to a fire in those days." He said that once it was decided to fight the fire practically every able-bodied man in New Grafton was called out.

A warden would go and look at a fire to see if it should be fought or not. People became concerned if a fire threatened timber (usually softwoods). If a fire were in hardwoods it was often left to burn itself out. The justification was that such a fire would make good browse for moose and, later on, for deer.

Allen Rowter feels there was more fire damage in the part of the park north and west of Kejimikujik Lake than other areas because of difficult access. People just couldn't get there to fight fires that did occur.

According to Leona Smith, the firefighters went with their own food and wet burlap bags. The only real weapon was to clear an area or dig a ditch to stop the fire. This

was probably in the nineteen-twenties and nineteen-thirties.

Willis says that Wajax pumps came into use in the nineteen-thirties. The original pumps weighed over 100 pounds. He once went to fight a fire on the Halfway (Old Annapolis) Road. Claude Morgan was the warden in charge of the group. They got as close as they could to the fire in a truck. There was quite a crew of men on the truck and two of the old Wajax pumps. As soon as the truck stopped the men all disappeared – except for Willis, Claude and Walter Sheffer. Claude said "It looks like you boys will have to carry those pumps by yourselves." It was over a mile and a half to the fire site and Willis and Walter each lugged one of those old pumps. Just as they got to the fire it started to pour and the fire was soon out. Willis said "If I have to lug that pump back by myself I guess it will stay here forever." He left it there. "Imagine," he said, "a truckload of men and we had to carry those pumps by ourselves."

Allen Rowter never was called on to fight a fire. He figured he'd been very lucky. The closest he came was when he heard a

crew go by in the night. He was logging near Little River in the summer of 1952. The crew was asleep when they were wakened by the sound of motor boats, old one-lungers from Kedge Lodge. They heard them heading up West River.

The next day they learned that there was a fire somewhere up West River. Bert Wagstaff was there with a Mersey crew. Walter Sheffer was there from the Lodge. The boats had taken the men as far as possible then they'd hiked in with backpacks and Wajax pumps. They got the fire out quite quickly.

Sometimes fighting fires went well, but that wasn't always the case. In the nineteen-sixties Willis fought a fire near Yeadon Bay on the southern shore of Lake Rossignol. They hoped to head the fire into a swamp where it would burn itself out. Unfortunately the wind changed and, with a crew of only five men, Willis couldn't contain the fire. He felt that if he'd had more men and equipment they could have been successful in their efforts to contain the fire. The fire burned an area of over 1000 acres, and covered a distance of 1½ miles, in less than 4 hours. At times

the fire was covering ground faster than a man could run. Willis said he was told that the fire around the McLare-Ford mine in 1921 burned that quickly as well.

Willis Forrest indicated that in the nineteen-sixties and nineteen-seventies, a number of fires were deliberately set, particularly in Westfield and on the Old Annapolis Road. The number of fires recorded from Westfield in provincial fire suppression records (Worden 1997) suggests an unusually high number of fires in the area. Willis suggested that in a time of high unemployment, fires might be deliberately set in order to provide salaried work. Willis added that it wasn't much money but perhaps better than none, and you "was always well fed."

Ralph Johnson (1952) lists all the fires that had occurred from 1930 until 1952, 19 in total, from all Mersey lands. Of those fires, four were caused by lightning, 10 from human carelessness or accidents (marsh burning - one, railway - one, hunters, fishermen, loggers, berry pickers etc. - eight), three were of unknown origin and two deliberately set. Areas burned range from 0.5 acres to 1000 acres. Two

of these fires were in the national park, one at Peskowsk Lake in 1946 (110 acres) and one at West River in 1952 (6 acres), and both were caused by lightning. A copy of the table accompanying Johnson's article is found in Appendix J.

Available national park forest fire records report seven forest fires in Kejimikujik from 1968 to 1987. Two were caused by lightning, five by carelessness (cigarette butts, etc.), one was deliberately set and the cause of one was not given (since it occurred at a backcountry campsite, humans were no doubt involved). The largest fire having occurred since the park's establishment burned an estimated 25 acres (10.1 hectares) at Mount Tom Brook in April 1973. These reports are summarized in Swain (1998) and outlined in Appendix S. Data from 1987 to 1990 are missing. Swain (1998) includes the circumstances of each fire, the weather at the time, and methods used during suppression.

Lightning fires occurred on Norway Island in 1991, near Rogers Brook in 1997, and at Luxton and Hilchemakaar Lakes in 1999. These last four fires are not summarized in

Swain (1998). All four were quickly extinguished by initial attack crews, each blaze never growing more than 0.1 hectares in size. These fires are pinpointed in Figure 7 (section 3.2.1).

There is little information on the size of early fires; available data are relatively sketchy. Since fires do not typically burn a uniform area, skimming over some places and igniting others, even historical information on the extent of individual fires can not be used to accurately predict the area burned. Figure 7 (section 3.2.1) indicates the estimated area covered by fires described in this section. Appendix M summarizes all known fires in the Kejimikujik region.

3.3.2 Historical fire weather analysis

This section of the report was adapted from research conducted by Ponamarenko and Woodley (1998).

Springfield station - Temperature, Precipitation and Wind Speed (1920-1994)

Over the 75-year period of record, no significant trends in either average or maximum temperature, or in mean 24-hour precipitation, were found. However, a

strong bias was detected across the temporal distribution of precipitation. Figure 17 shows the number of days with rain from 1920-1994 and their rapid increase in frequency over the 75 year period.

The average precipitation per rainy day was plotted over time (see Figure 18). A strong downward trend in average precipitation per rainfall is readily apparent. Both Figures 17 and 18 also show distinct breaks in the trend line in the

years 1930 and 1980; this is evident in the 3-year running mean.

The distinct breaks in precipitation's time line (Figures 17 and 18) were used to divide data into three periods; 1920-1930, 1931-1980, and from 1981-1994. For each of the three intervals, we calculated the average precipitation, the average number of rainy days, and the average number of rains greater than 2mm. These results are presented in Figure 19. A

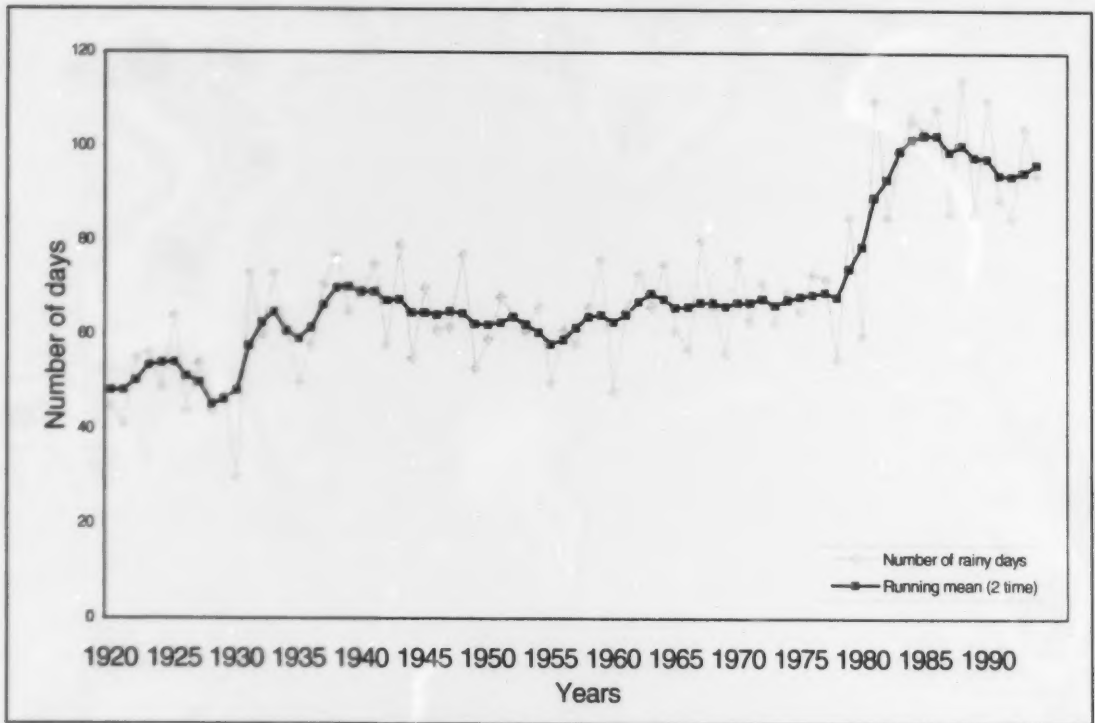


Figure 17. Number of days per year with rain in the period of May-October, 1920-1996 for Springfield, Nova Scotia. Running mean calculated at two year intervals.

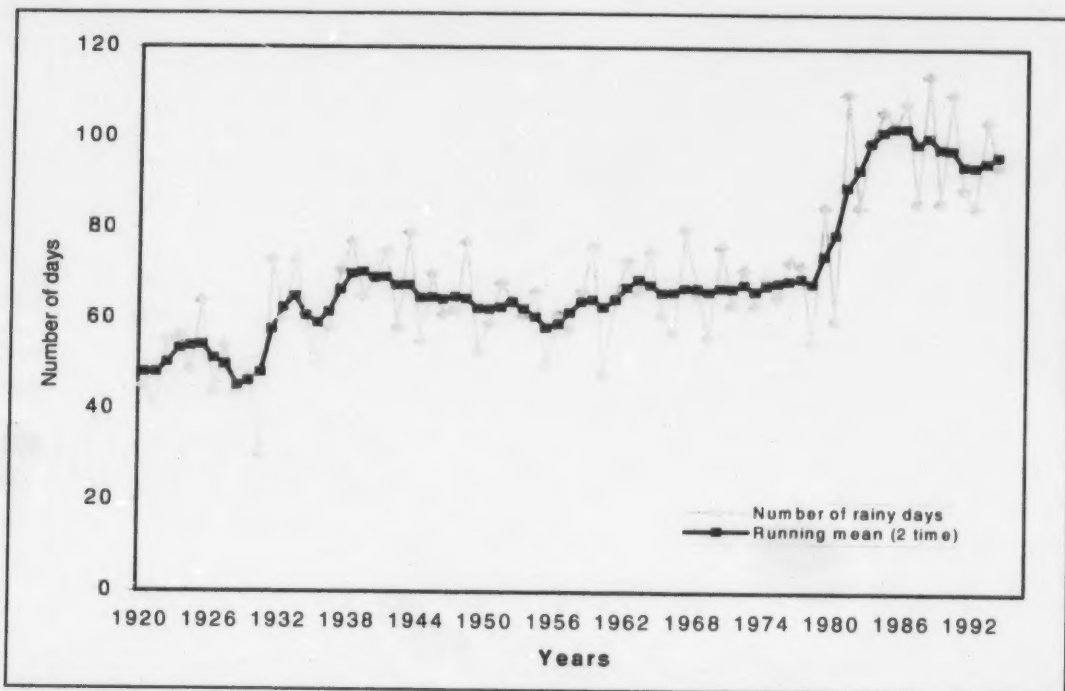


Figure 18. Average precipitation per rainy day from Springfield, Nova Scotia, 1920-1994. Running mean calculated at two year intervals.

dramatic change between the three time periods in Figure 19 is evident. Data show, not a shift in the total amount of precipitation, but in the distribution of precipitation. The average number of rainy days per year more than doubled between the 1920-1930 and the 1980-1994 periods. The least number of rainy days occurred in 1930 (30 days with rain) and the most number of rainy days occurred in 1988 (174 days with rain). Differences between periods for the average number of rainy days and the average precipitation per rainfall are significant at the 95% confidence level. The number of rainy

days does not appear to be tightly connected with total precipitation because average rainfall is decreasing.

Figure 19 also reveals an increase in rains of less than 2 mm after 1930 and an decrease in the average precipitation per rainy day over the last 75 years. The overall pattern is a reduced precipitation flux from year to year and an increased abundance of small rain events. This trend could have significant effects on fire regime. Fine fire fuels are less likely to dry with an increase in rain days than with an overall increase in total precipitation.

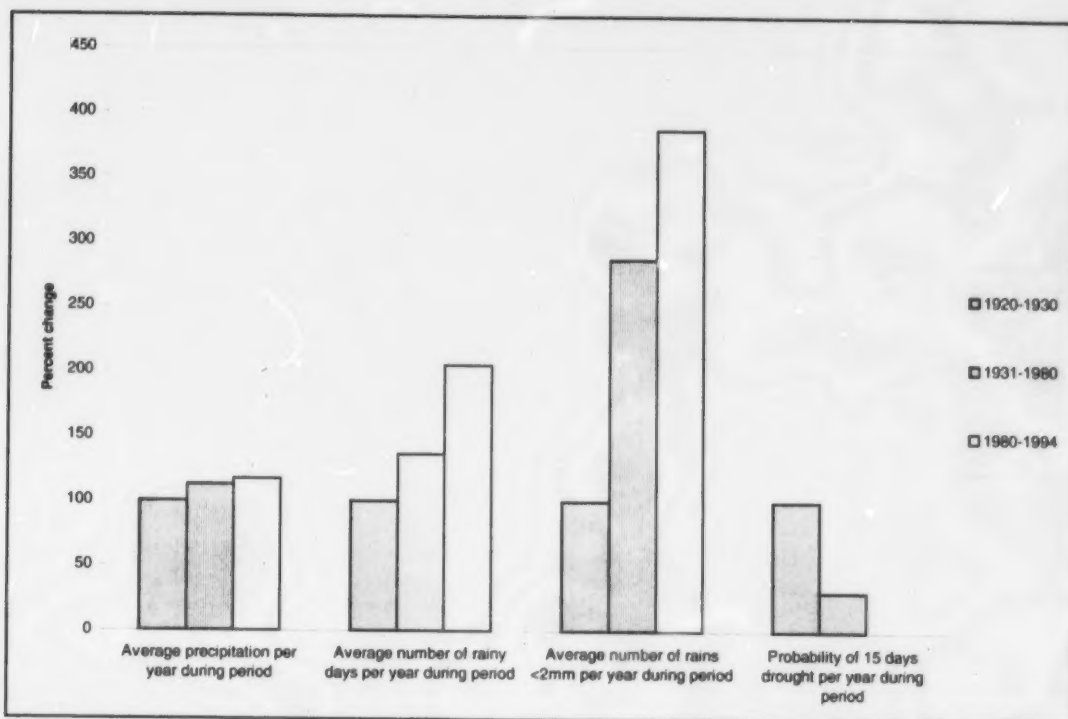


Figure 19. Changes in precipitation characteristics during the May 1- October 31 period (Springfield, Nova Scotia, 1920-1994). All values are expressed as a % change from the original period (1920-1930)

Over the entire 75-year record, annual precipitation ranged from 327mm to 864 mm. The driest year was 1965 and wettest was 1990. The dryer years tend to be grouped in the earlier part of the century and the wettest years in the later part of the century. The probability of 15 day droughts has dropped to 0 in the 1980-1994 period. The decreasing frequency of droughts is illustrated in Figure 20. The probability of a drought (of any length) is highest prior to 1930 (Figure 20). Seven-day droughts occurred more than seven times per year from 1920-1930 then falling

to less than one time per year from 1980-1994. The probability of 7, 10, 12, and 15 day droughts changed in a similar manner. During the last period (1980-1994), there were no 15 day droughts and only one 12 day drought. In contrast, the first period (1920-1930) had more than one 12-day drought each year.

Changes in the Forest Fire Danger Rating System - Greenwood Station

May 1-October 31, 1953-1994 data from Greenwood were used to calculate the codes and indices of the Canadian Fire

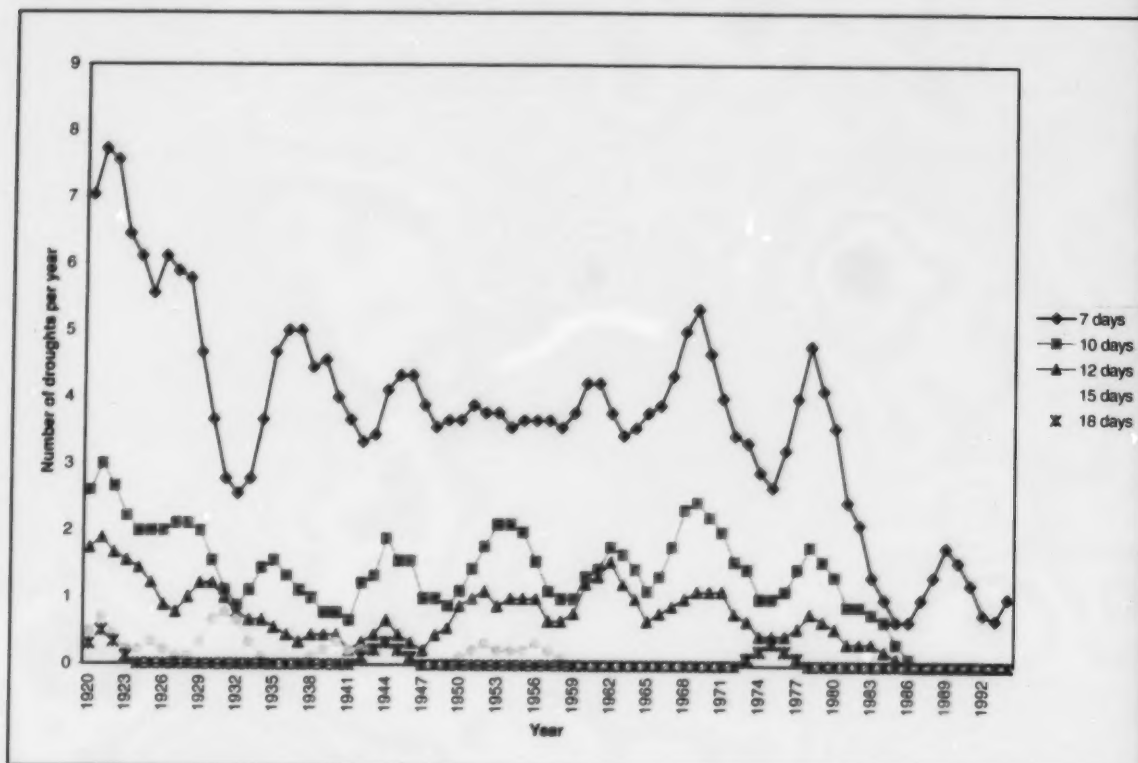


Figure 20. Probability of droughts of different lengths, from Springfield, Nova Scotia, 1920-1994 (2 year running average).

Danger Rating System. These included Fine Fuel Moisture Code (FFMC), Duff Moisture Code (DMC), Drought Code (DC), Initial Spread Index (ISI), Build Up Index (BUI), Fire Weather Index (FWI), and the Daily Severity Rating (DSR). The DRS is a measure of the difficulty in suppressing a given fire. It is calculated from the Fire Weather Index as a power function (Van Wagner 1987). The DSR is the best index for cross-season averaging. Figure 21 shows the seasonal average Daily Severity Rating from 1995-1994 and

its decreasing trend. Figure 22 shows the number of days per year that the DSR was above 8 (fires which are very difficult to control). Overall, the incidence of days with a DSR greater than 8 decline from 1953 to 1994. This mirrors the trend in precipitation distribution found at the Springfield station. We also compared the average DSR in the period before and after 1980, using the same time break noted for the Springfield station. The mean DSR after 1980 (1981-1994) was significantly

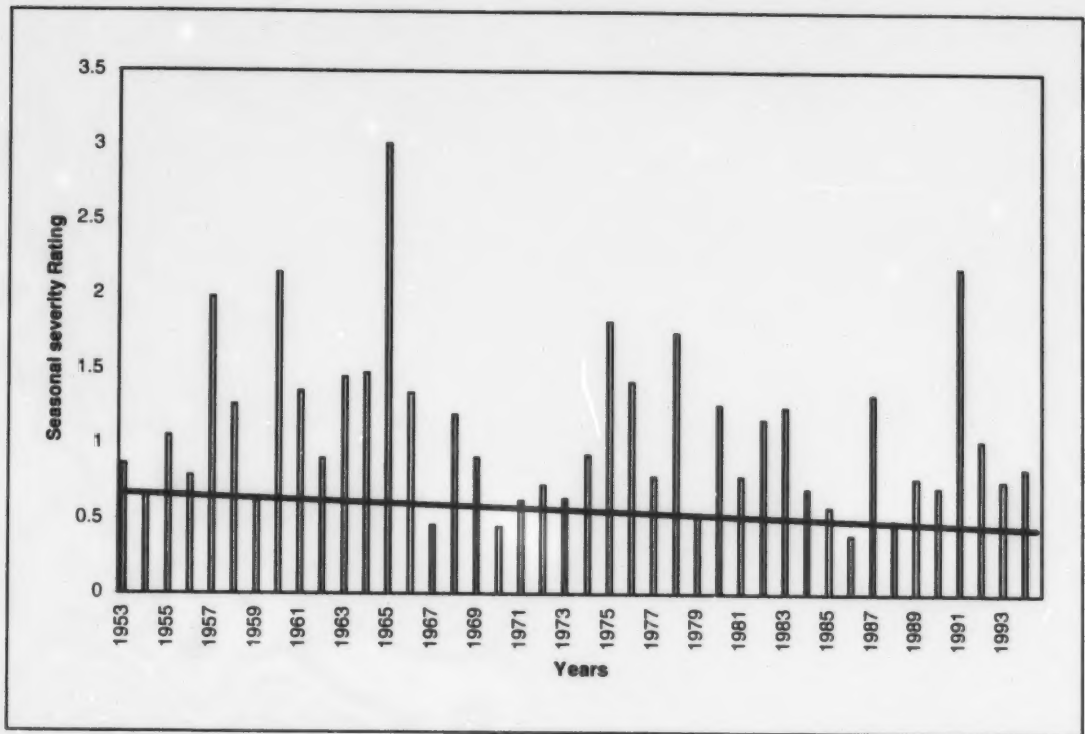


Figure 21. Seasonal daily severity rating averages for the period May 1-October 31, 1953-1994, Greenwood Nova Scotia.). The DRS is a measure of the difficulty in suppressing a given fire. It is calculated from the Fire Weather Index as a power function (Van Wagner 1987)

lower (95% confidence interval) than the mean DSR value before 1980 (1953-1980).

Changes in Number and Size of Forest Fires in Nova Scotia, 1953 - 1994

We examined changing fire danger (as DSR) and precipitation patterns in the context of the total number and of average area of forest fires in Nova Scotia from 1953-1997. Available fire size data were collected province wide so we expected a weak correlation with the localized

Greenwood weather station. A strong correlation might have indicated a more general change in climate for Nova Scotia. The total number of fires per year does not change significantly over the 1953 - 1994 period. However there is a dramatic decrease in the fire size over the same period (Figure 23).

We compared area burned, fire size and number of fires burned, again for the pre and post 1980 period (Figure 23, 24). Figures 23 and 24 show a significant

reduction in average fire size. Because the numbers of fires is relatively constant, there is also a corresponding decrease in total area burned. Such data correlates with the reduction in droughts, increase in rainy day frequency, and lowered Daily Severity Rating as discussed earlier.

Conclusions

There are significant changes in the distribution of precipitation between 1920

and 1994. It appears that the period can be divided into three intervals of change:

1920-1930, 1931-1980, and 1981-1982.

Total precipitation changed slightly during these periods but the average number of rainy days per year more than doubled, the average precipitation per rainy day decreased by 56%, and the probability of a 7-day drought decreased more than 7

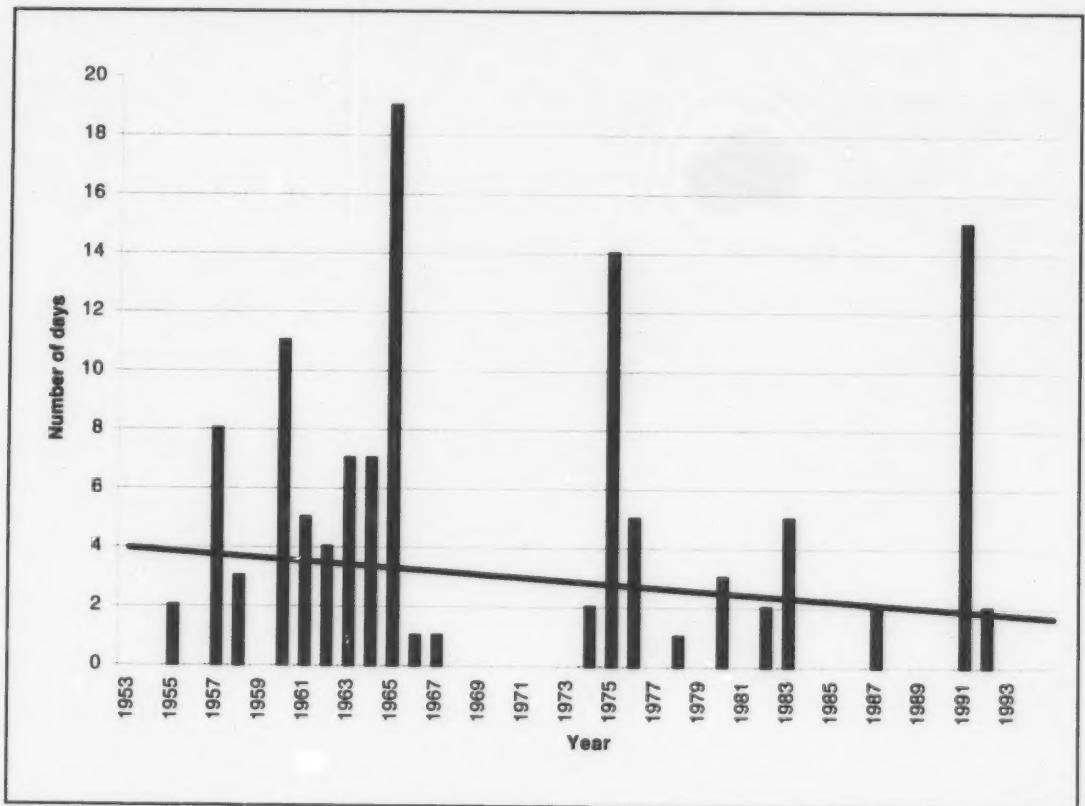


Figure 22. Number of days per year with a daily severity rating greater than 8 for the period May 1 - October 31, 1953-1994, Greenwood, Nova Scotia. The DRS is a measure of the difficulty in suppressing a given fire. It is calculated from the Fire Weather Index as a power function (Van Wagner 1987).

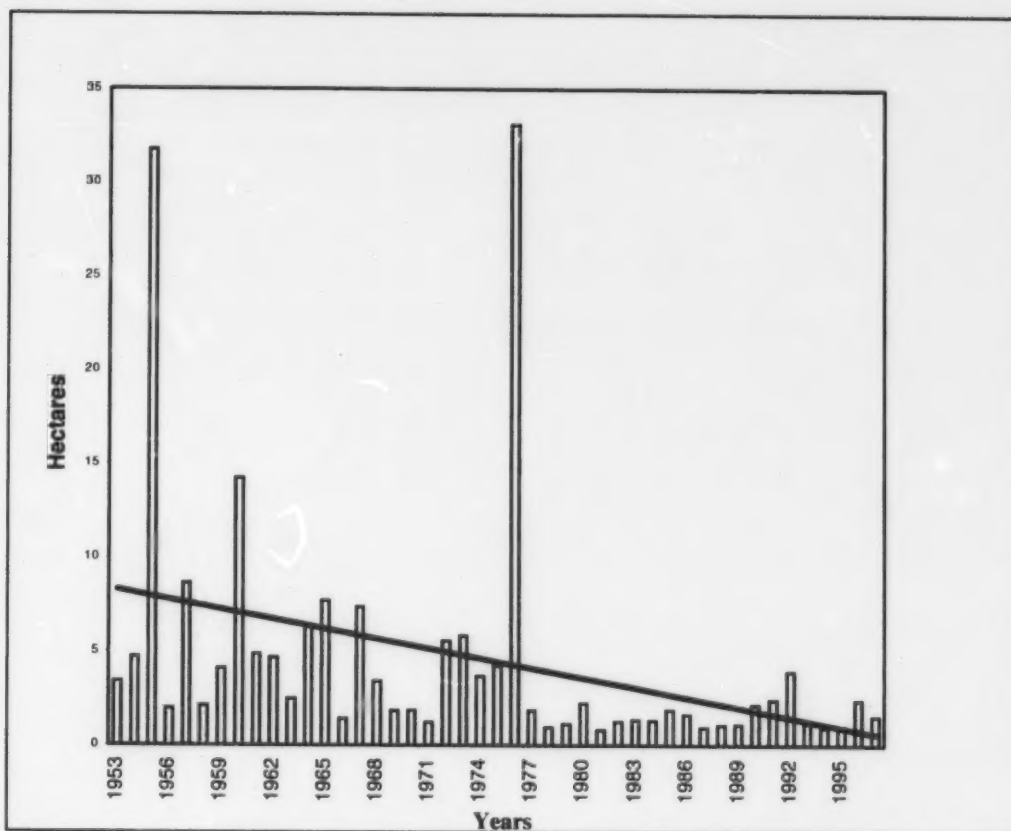


Figure 23. Average forest fire size (hectares) by year in Nova Scotia from 1953-1997.

times. These changes indicate that the general weather pattern changed during the 1920 to 1994 period. Changing air mass flow patterns, driven by fluctuations in the jet stream, are a possible cause. In the first period from 1920 - 1930, Nova Scotia summers were more likely influenced by drier continental air masses, in last period

by marine air masses. The declining seasonal average in DSR, and the number of days with a DSR greater than 8, corresponds with a decrease in mean fire size over the same period. This decrease

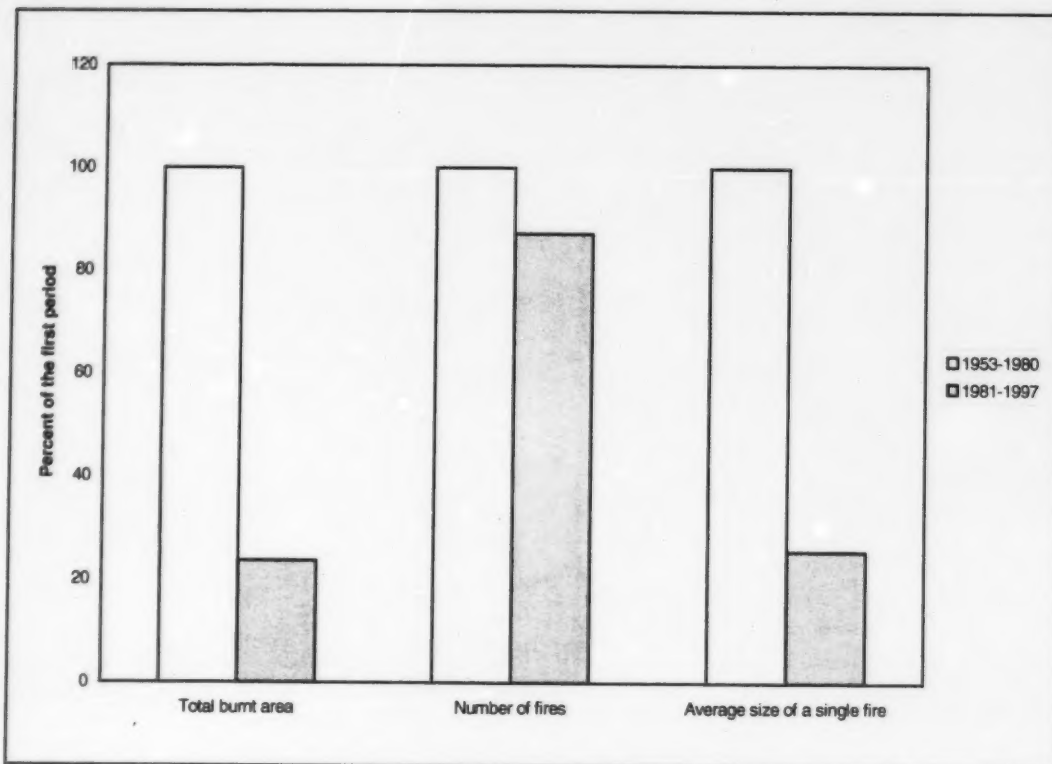


Figure 24. A comparison of the number of fires and area burnt for two periods, 1953-1980 and 1981-1997, Nova Scotia. Data is graphed to show the relative percentage of fires (number, area, and size) in the 1953-1980 period represented in the period 1981-1997.

in fire size could be related to increased efficiency of fire suppression with the introduction of rapid initial attack procedures. However, we know of no change in fire organization that could explain this shift. The weight of evidence favors the conclusion that changing weather patterns have resulted in a changing fire regime. It is worthy to note however, that the inconstancy we detected in fire regime might be insignificant in a longer term context.

3.4 Fire effects on forest structure

This section details the effects of fire on the development and succession of each sample stand type, the influence of continued fire suppression on their structure and composition, and a record of the fire history and structural attributes found for each (outlined in Tables 17 through 25). Appendix P particularizes the typical fire scar physiognomy and most optimal means of sampling, preserving,

and interpreting bole cross-sections for all of the tree species sampled in this study. Section 3.4 is summarized in Table 26.

3.41 *Pinus strobus* (white pine)

White pine is the tallest and largest of Atlantic Canada's tree species; it is also fast growing and long-lived (Farrar 1995). These qualities made it the prime target for eighteenth and nineteenth century loggers (Wein and Moore 1979, Goldsmith 1980). Once occurring in vast pure stands (Wendel et al. 1990), the species is now largely isolated to small pockets of secondary growth, and a component of mixed hardwood and softwood forests (Wendel et al. 1990, Farrar 1995). In Kejimikujik, very few large (with a breast height diameter over seventy centimeters) old white pine trees exist.

White pine stands were typically found on the park's eskers and drumlins and generally in areas with sandier soil. Overstory canopies were typically thick with semi-mature to mature trees (see Figure 25). Large old white pine were less common in Kejimikujik's pure pine stands, found more often as isolated stems in mixed stands of red spruce and hardwood, or widely interspersed in hemlock forests.

In sample stands, red maple was the codominant canopy species and the dominant subcanopy tree (Table 16); it was not uncommon to find large red pine as isolates or in clusters. Undergrowth was either very thick or very thin. High understory densities of hardwoods and larger shrub species such as huckleberry (*Gaylussacia baccata*) were not unusual. Most of the ground vegetation was comprised of shrub and fern species (see Table 16). Mosses were relatively uncommon as were clubmosses, grasses, and lichens.

Direct logging evidence (i.e. old stumps) in white pine forests was less common than expected though other signs of disturbance, perhaps associated with logging, such as overgrown roads, abandoned buildings, and old pieces of garbage were prevalent. Fire evidence was more common in these stands than any other with the exception of the hemlock sites (Table 16). Charred wood was found on deadwood, roots, and live trees and was very common in the soil and humus layers. It was not unusual to encounter very old stumps or snags with bits of charcoal still clinging to them.



Figure 25. Photograph of a typical white pine stand sampled from Kejimikujik National Park.

White pine comprised the largest proportion of homogenous stands in the park, the species a thriving competitor in the area. In this section of Acadian forest, white pine dominates in old field successional communities and is one of the more common understory softwoods (Loucks 1962, Rowe 1972). Historic evidence, however, shows that this species' ability to maintain canopy dominance depends heavily on site history.

Martin (1956) documents post-fire successional forest communities in southwestern Nova Scotia. In stands

where white pine predominated, fire typically killed all canopy and pole-sized species (typically mixed white pine, red spruce, and balsam fir), with the exception of white pine. In the ten years that followed, pioneer species such as white birch, large toothed aspen, red spruce, and red maple out-competed the self-seeded white pine. After fifty years, however, white pine replaced these pioneer species and began reestablishing itself throughout the canopy. This scenario differed in logged areas where seed-bearing canopy trees were harvested out; in these instances red spruce, red maple and or white birch

were more likely to replace white pine as the new canopy.

Eastern white pine is relatively well adapted to fire (see Carey 1993a for review). Older stems have thickened bark, few ladder fuels, and deep roots. Across its range, the species has evolved under a mixed intensity fire regime. White pine typically experiences overstory fires every 150–350 years; these fires help prepare an optimal seedbed and reduce competition. Older stands (trees ≥ 18 meters in height) tolerate low to moderate intensity surface fires; such burns have been shown to improve recruitment.

In Kejimikujik, white pine stand replacement will depend heavily on larger scale disturbances such as fire. Fire has an extensive historic role in initiating purer stands; 60% of our samples show very

strong evidence of their fire origins. In southwestern Nova Scotia, previous studies have shown the important role fire plays in the development of white pine stands, helping to support our findings (Martin 1956, Saunders 1970, Stanley et al. 1973, Anon. 1984).

The majority of sampled white pine sites, of both fire and other origin, have experienced historic understory fire (80% of samples). Such fires have very likely played an important role in the maintenance of Kejimikujik's white pine forests. Forty percent of sample stands showed a tiered age-class distribution thus indicating the production of a pulse of new recruits very likely following an understory fire event. Successful white pine recruitment has been reported to be governed in part by fire (e.g. Methven 1973).

Table 16. Outline of the quantitative and qualitative attributes of white pine study stands. See appendix A for list of species acronyms and Latin binomials. Mean percentages of dominant and subdominant canopy trees were calculated using coverage values measured across all sample plots. Mean densities of regenerating tree species are given in stems/hectare and basal area (square meters/hectare); mean abundance of non-tree species is given as percent cover. The effect of fire scarring on mortality was subjectively indexed from fire-scarred basal cross-sections and canopy condition (see appendix C). (na - not available; dbh - diameter at breast height; GIS - geographic information system; KNP - Kejimikujik National Park; n - sample size; NA - not applicable/available; ha - hectares; m - meters; cm - centimeters)

Stand type	White pine (n=5)	Data
Canopy composition	Dominant species - GIS	85% (wP)
	Dominant species - field data	96% (wP)
	Subdominant species 1 - field data	4% (rM)
	Subdominant species 2 - field data	NA
Subcanopy composition	Dominant species - field data	41% (rM)
Physiography	Number stands in KNP	748
	Mean area	5.3 ha
	Combined area	3979 ha
	Proportion (%) of study area	55%
	Proportion (%) of KNP's forests	14%
Overstory structure	Mean height	26.2 m
	Mean dbh	40.4 cm
	Mean age	92.3 ± 37.5 years
	Density	95.5 ± 4.8%
Understory structure	Dominant species #1	wP (563750/ha; 0.54 m ² /ha)
	Dominant species #2	rM (113334/ha; 1.17 m ² /ha)
	Dominant species #3	stM (75000/ha; 0.08 m ² /ha)
Herb and shrub layer (non-tree species)	Dominant species #1	Low-bush blueberry (34.3%)
	Dominant species #2	Huckleberry (10%)
	Dominant species #3	Velvet-leaf blueberry (6%)
Fire history	Charcoal presence (% of samples)	100%
	Surface fire presence (% of samples)	80%
	Mean number ground fires/sample	4
	Mean fire interval (ground fires)	15 years
	Known fire origin (% of samples)	60%
	Scarring effect on mortality	minimal

3.4.2 *Pinus resinosa* (red pine)

Red pine stands are relatively uncommon in this area. The species is most often found mixed with white pine, in narrow

strips around lakeshores, and as isolated stands in previously burned areas (Saunders 1970, Gimbarzevsky 1975). The tree grows best on fine sandy soil or

ash left by forest fire (Rudolph 1990, Farrar 1995).

Red pine stands were found in one of two probable stages of succession. One of the stages was marked by the complete absence of understory strata, the other a thick undergrowth of black or white spruce. All stands appeared very open, even-aged, and pure (see Figure 26). Red pine stands were almost always on elevated sites. Where black spruce recruits existed, they appeared to have colonized from wetter areas, sometimes

found adjacent. Codominants included white pine isolates and scattered red maple and or white birch stems. Red pine crowns were usually dense. Shrub and ground species were not prevalent, bracken fern (*Pteridaceae aquilinum*) much more common.

Evidence of harvesting was very uncommon. However, most if not all red pine stands were found in somewhat inaccessible areas. Fire scars were not prevalent; all scars were found on large relict stems and in a couple cases on



Figure 26. Photograph of a typical red pine stand sampled from Kejimikujik National Park.

groups of smaller trees, closely clustered together. Prominent fire scars were more often encountered on white pine isolates than the dominant reds. Many red pines showed no visible sign of injury. Careful analysis however revealed minor fire scars deeply embedded beneath layers of unmarred bark and smooth scar tissue. Charcoal was extremely prevalent and abundant in duff and soil layers.

Red pine is arguably the most fire adapted tree species in southwestern Nova Scotia (Saunders 1970, Stanley et al. 1973, Anon. 1984; see Carey 1993b for review). The tree has very fire resistant bark, provides little surface or ladder fuels, has moderately deep roots, and grows with an open stand structure. Red pine has evolved in a fire regime characterized by intense overstory burns every 150-200 years and less intense understory burns at 20 – 40 year intervals. The species requires periodic surface fire to ensure successful understory recruitment. Outside of carefully managed silvicultural operations, stand-scale red pine communities are always linked with fire. The species thrives in the mixture of ash and exposed sandy soil left in fire's wake (Carey 1993b).

Sampled red pine stands revealed three striking attributes. Every sample exhibited a very narrow age-distribution of canopy trees, an obvious deficit of red pine understory recruits, and a thick layer of charcoal in the humus/soil. As such, all samples were reasoned to have originated with overstory fire. Although sixty percent (Table 17) of samples were exposed to at least one understory burn, red pine recruits were not found in the understory. This may stem from the lack of good seed years in the species (Engstrom and Mann 1991), or characteristics of the burns, such as their timing or intensity, which may have hindered germination. Two thirds of such stands did however show a tiered canopy age class distribution, indicating the possible role of fire in initiating pulses of regeneration during the early years of the stands' development.

In the absence of fire, the most likely seral species replacing these pure stands would be black spruce, balsam fir, and or red spruce. In the absence of fire, red pine stands will be lost from Kejimikujik National Park.

Table 17. Outline of the quantitative and qualitative attributes of red pine study stands. See appendix A for list of species acronyms and Latin binomials. Mean percentages of dominant and subdominant canopy trees were calculated using coverage values measured across all sample plots. Mean densities of regenerating tree species are given in stems/hectare and basal area (square meters/hectare); mean abundance of non-tree species is given as percent cover. The effect of fire scarring on mortality was subjectively indexed from fire-scarred basal cross-sections and canopy condition (see appendix C). (na - not available; dbh - diameter at breast height; GIS - geographic information system; KNP - Kejimikujik National Park; n - sample size; NA - not applicable/available; ha - hectares; m - meters; cm - centimeters)

Stand type	Red pine (n=5)	Data
Canopy composition	Dominant species - GIS	76% (rP)
	Dominant species - field data	92% (rP)
	Subdominant species 1 - field data	6% (bS)
	Subdominant species 2 - field data	2% (rS)
Subcanopy composition	Dominant species - field data	40% (rS)
Physiography	Number stands in KNP	9
	Mean area	2.6 ha
	Combined area	23.7 ha
	Proportion (%) of study area	0.3%
	Proportion (%) of KNP's forests	0.08%
Overstory structure	Mean height	23.2 m
	Mean dbh	36.2 cm
	Mean age	75.1 ± 11.2 years
	Density	93.1 ± 4.8%
Understory structure	Dominant species #1	mtM (60000/ha; 0.28 m ² /ha)
	Dominant species #2	bS (35000/ha; 2.98 m ² /ha)
	Dominant species #3	wS (20000/ha; 3.77 m ² /ha)
Herb and shrub layer (non-tree species)	Dominant species #1	bracken fern (33%)
	Dominant species #2	kalmia (23%)
	Dominant species #3	moss spp. (9.8%)
Fire history	Charcoal presence (% of samples)	100%
	Surface fire presence (% of samples)	60%
	Mean number ground fires/sample	3.3
	Mean fire interval (ground fires)	16.9 years
	Known fire origin (% of samples)	100%
	Scarring effect on mortality	minimal

3.4.3 *Picea rubens* (red spruce)

Red spruce is the one tree species that distinguishes the Acadian forest from all other regions (Rowe 1972). Red spruce is

also one of the most prevalent Acadian softwoods, across Nova Scotia second only to *Abies balsamea* (Saunders 1970). In the southwestern part of the province,

however, the species is less dominant, though still found in abundance.

P. rubens occurs in both pure and mixed stands throughout its range (Blum 1990).

Although the species can be found in mesic lowland areas, it grows best on moist but well-drained upland sites (Farrar 1995). In Kejimikujik, the species is found in both low and upland areas, and is often closely associated with black spruce; pure stands of red spruce were only found in well-drained sites. Stands of red spruce were typically dense, and heavily interspersed with deadwood; understory

strata were dominated by balsam fir; cinnamon (*Osmunda cinnamomea*) and bracken ferns (*P. aquilinum*) were common (see Figure 27, Table 18).

Some logging evidence was found in sampled areas though not with notable frequency. Old white pine stumps were encountered as was the occasional logging road. Charcoal was common in the soil but less so in the humus; very few fire scars were found.

Forty percent of Kejimikujik's red spruce stands very likely originated with stand



Figure 27. Photograph of a typical red spruce stand sampled from Kejimikujik National Park.

replacing fire. Red spruce is not however considered a fire adapted or otherwise typical post-fire species (see Sullivan 1993 for review). In burned areas, red spruce is reported to appear after pioneer hardwoods such as white birch and aspen, in time establishing dominance with balsam fir to replace the hardwood canopy (Sullivan 1993). In southwestern Nova Scotia the situation may differ. Martin (1956) used pre-fire forest structural variables documented by Fernow (1912) to outline successional changes twenty-nine and forty years after a burn. In the more recent post-burn site, red spruce saplings dominated; in the older site, red spruce again dominated although white pine was predicted to replace it soon after.

In general, overstory fires have been shown to promote red spruce germination but only under certain circumstances (Wright and Bailey 1982, Sullivan 1993).

Prescribed burning has been used successfully where available moisture was not a limiting factor (see Wright and Bailey 1982). In Kejimikujik, red spruce forests will persist without stand replacing fire though the incidence of pure even-aged stands may decrease.

Red spruce is highly prone to fire damage (Blum 1990). Although the species has the thickest bark of the three Acadian spruces (Burns and Honkala 1990), even low to moderate intensity surface fires have been reported as lethal (Sullivan 1993). Red spruce is also predisposed by its shallow roots, abundant ladder fuels, and highly flammable needles. In this study, few fire scarred red spruce were found, two samples with multiple scars being the exception. In the absence of fire, these stands will likely continue their shift towards pure softwood (see Gimbarzevsky 1975).

Table 18. Outline of the quantitative and qualitative attributes of red spruce study stands. See appendix A for list of species acronyms and Latin bionomials. Mean percentages of dominant and subdominant canopy trees were calculated using coverage values measured across all sample plots. Mean densities of regenerating tree species are given in stems/hectare and basal area (square meters/hectare); mean abundance of non-tree species is given as percent cover. The effect of fire scarring on mortality was subjectively indexed from fire-scarred basal cross-sections and canopy condition (see appendix C). (na - not available; dbh - diameter at breast height; GIS - geographic information system; KNP - Kejimikujik National Park; n - sample size; NA - not applicable/available; ha - hectares; m - meters; cm - centimeters)

Stand type	Red spruce (n=5)	Data
Canopy composition	Dominant species - GIS	91% (rS)
	Dominant species - field data	70% (rS)
	Subdominant species 1 - field data	8% (rM)
	Subdominant species 2 - field data	8% (bF)
Subcanopy composition	Dominant species - field data	80% (rS)
Physiography	Number stands in KNP	121
	Mean area	4.7 ha
	Combined area	565 ha
	Proportion (%) of study area	7.8%
	Proportion (%) of KNP's forests	2%
Overstory structure	Mean height	14.9 m
	Mean dbh	15.3 cm
	Mean age	61.4 $\pm$ 23.6 years
	Density	90.5 $\pm$ 4.8%
Understory structure	Dominant species #1	rM (261250/ha; 0.25 m ² /ha)
	Dominant species #2	wP (66667/ha; 0.06 m ² /ha)
	Dominant species #3	bF (52500/ha; 1.24 m ² /ha)
Herb and shrub layer (non-tree species)	Dominant species #1	moss spp. (62%)
	Dominant species #2	cinnamon fern (11%)
	Dominant species #3	<i>kalmia</i> (3.8%)
Fire history	Charcoal presence (% of samples)	60%
	Surface fire presence (% of samples)	20%
	Mean number ground fires/sample	1
	Mean fire interval (ground fires)	NA
	Known fire origin (% of samples)	40%
	Scarring effect on mortality	average

3.4.4 *Picea mariana* (black spruce)

Black spruce is widely distributed throughout the Acadian region, in Nova Scotia, fourth in abundance among the softwoods (Saunders 1970). The species is associated with boggy or otherwise poorly drained lowland areas but also does well in drier sites (see Figure 28). Black spruce is usually found in pure stands on organic soils, in mixed stands on mineral soil (Viereck and Johnston 1990).

Black spruce often reproduce through layering, or the rooting of hanging branches, particularly in areas with a thick

organic mat (Farrar 1995). The tree also establishes itself very successfully after fire as its cones are semi-serotinous, post-fire conditions ideal for success seed germination (Uchytel 1991b).

Black spruce were found in both poorly drained and moderately drained areas of Kejimikujik. The mesic sites were typical of all boggy sites in the Maritime provinces; a thick *sphagnum* spp. mat covered the forest floor, black spruce dominated both canopy and subcanopy layers; red maple and occasionally larch were found scattered throughout (Table



Figure 28. Photograph of a typical black spruce stand sampled from Kejimikujik National Park.

19). Mosses and grasses were prevalent in all stands, as were bunchberries (*Cornus canadensis*), *kalmia*, partridge berry (*Mitchella repens*), twin flower (*Linnaea borealis*), and various ferns. Black spruce stands were found in sites with low slope gradients.

Evidence of logging and fire was scarce to nil. There were no roads, with few, if any, fire or blaze scars. In wetter sites, the thick moss mat often contained charcoal evidence though never in a uniform layer.

Black spruce is both an early and late successional species (see Viereck and Johnston 1990 for review). In fire prone areas the species will quickly invade burned sites, provided a seed source is available. The species usually maintains dominance unless fire is excluded from such environments, whereupon balsam fir is the typical replacement species (Uchytel 1991b). In wetter areas, the species outcompetes all others.

In behaving similar to their parent region, elements of the boreal forest, such as the

outlying black spruce stands found throughout the Acadian region, are thought to be maintained in part by fire (Heinselman 1981). Previous research conducted in the area lend similar support (Saunders 1970, Rowe 1972, Stanley et al. 1973). Rowe (1972) for example indicates that black spruce now dominates many of the fire barrens B.E. Fernow outlined in 1912.

Most of the black spruce stands sampled for this study were in wetter lowland areas, where fire return intervals are likely much longer. Our results revealed forty percent of sites did originate with fire; surface fires were very uncommon (see Table 19). Overstory fire is not likely needed to maintain black spruce stands in the region though the incidence of pure even aged stands will probably drop in their absence. Continued fire suppression will skew better drained black spruce sites to a mixed forest where black spruce, red maple, and balsam fir are codominant; even-aged lowland forests will shift to a multiple cohort age structure with increased numbers of red maple and larch.

Table 19. Outline of the quantitative and qualitative attributes of black spruce study stands. See appendix A for list of species acronyms and Latin binomials. Mean percentages of dominant and subdominant canopy trees were calculated using coverage values measured across all sample plots. Mean densities of regenerating tree species are given in stems/hectare and basal area (square meters/hectare); mean abundance of non-tree species is given as percent cover. The effect of fire scarring on mortality was subjectively indexed from fire-scarred basal cross-sections and canopy condition (see appendix C). (na - not available; dbh - diameter at breast height; GIS - geographic information system; KNP - Kejimikujik National Park; n - sample size; NA - not applicable/available; ha - hectares; m - meters; cm - centimeters)

Stand type	Black spruce (n=5)	Data
Canopy composition	Dominant species - GIS	na (bS)
	Dominant species - field data	72% (bS)
	Subdominant species 1 - field data	12% (rM)
	Subdominant species 2 - field data	8% (La)
Subcanopy composition	Dominant species - field data	73% (bS)
Physiography	Number stands in KNP	29
	Mean area	5.1 ha
	Combined area	144.8 ha
	Proportion (%) of study area	2.0%
	Proportion (%) of KNP's forests	0.5%
Overstory structure	Mean height	11.1 m
	Mean dbh	13.6 cm
	Mean age	66.8 ± 18.1 years
	Density	89.6 ± 4.8%
Understory structure	Dominant species #1	rM (295000/ha; 1.02 m ² /ha)
	Dominant species #2	bS (32500/ha; 1.75 m ² /ha)
	Dominant species #3	NA
Herb and shrub layer (non-tree species)	Dominant species #1	moss spp. (64%)
	Dominant species #2	grass spp. (8.3%)
	Dominant species #3	bunchberry (6%)
Fire history	Charcoal presence (% of samples)	80%
	Surface fire presence (% of samples)	20%
	Mean number ground fires/sample	2
	Mean fire interval (ground fires)	NA
	Known fire origin (% of samples)	40%
	Scarring effect on mortality	Average

3.4.5 Mixed softwood (*Picea* sp., *Betula papyrifera*)

Kejimikujik has numerous mixed forest communities. A mixed softwood stand type was selected for sampling based upon its structural and compositional similarity to the boreal forest. This stand type was found primarily in moderate to well drained areas with low to medium slope gradients. In the 1992 GIS database, these stands were classified as containing at least sixty percent spruce and twenty percent intolerant hardwood.

Our samples revealed a community dominated by spruce (usually red) with a large component of white birch, red maple, and or balsam fir (see Table 20). Samples were not always mixed evenly; pockets of hardwood were common, as were *Alnus* swamps in some of the lower lying sites, and the occasional white pine stem. Snags and deadfalls were prevalent in conifer dominated areas. Most stands were a diverse mix of large and small, young and old, hardwood and softwood trees (see Figure 29).



Figure 29. Photograph of a typical mixed softwood stand sampled from Kejimikujik National Park.

Old roads were found scattered through most mixed softwood sample sites. Harvesting likely occurred in the early to middle part of the twentieth century. Few white pine were found, the small number encountered being the only trees with fire scarring evidence. On the whole, evidence of fire was close to nil.

Logging appears to be the dominant historic disturbance force in Kejimikujik's mixed softwood stands. Gimbarzevsky (1975) indicates that the pocket hardwood stands found scattered through these mixed forests are the result of selective harvests having occurred before the park's establishment. It is expected that the absence of logging in the future will skew

these stands towards pure softwood as hardwood pockets are replaced with shade-tolerant species such as balsam fir, hemlock, and or red spruce.

Fire has not had a large role in either mixed softwood stand initiation or maintenance. In the continued absence of fire, these stands will continue their trend towards pure softwood (as mentioned above). Fires will promote the increased dominance of sprouting species such as white birch and red maple and possibly moderately flame resistant species such as white pine and hemlock.

Table 20. Outline of the quantitative and qualitative attributes of mixed softwood study stands. See appendix A for list of species acronyms and Latin binomials. Mean percentages of dominant and subdominant canopy trees were calculated using coverage values measured across all sample plots. Mean densities of regenerating tree species are given in stems/hectare and basal area (square meters/hectare); mean abundance of non-tree species is given as percent cover. The effect of fire scarring on mortality was subjectively indexed from fire-scarred basal cross-sections and canopy condition (see appendix C). (na - not available; dbh - diameter at breast height; GIS - geographic information system; KNP - Kejimikujik National Park; n - sample size; NA - not applicable/available; ha - hectares; m - meters; cm - centimeters)

Stand type	Mixed softwood (n=5)	Data
Canopy composition	Dominant species - GIS	62(S)/20(IH)%
	Dominant species - field data	40(S)/20(IH)%
	Subdominant species 1 - field data	18% (bF)
	Subdominant species 2 - field data	16% (He)
Subcanopy composition	Dominant species - field data	50% (rM)
Physiography	Number stands in KNP	105
	Mean area	6.7 ha
	Combined area	702.4 ha
	Proportion (%) of study area	9.7%
	Proportion (%) of KNP's forests	2.5%
Overstory structure	Mean height	19.0 m
	Mean dbh	27.7 cm
	Mean age	69.0 ± 27.3 years
	Density	91.8 ± 4.8%
Understory structure	Dominant species #1	rM (72500/ha; 0.48 m ² /ha)
	Dominant species #2	He (40000/ha; 0.02 m ² /ha)
	Dominant species #3	wP (25000/ha; 0.01 m ² /ha)
Herb and shrub layer (non-tree species)	Dominant species #1	moss spp. (47%)
	Dominant species #2	<i>kalmia</i> (12.5%)
	Dominant species #3	bracken fern (11.5%)
Fire history	Charcoal presence (% of samples)	80%
	Surface fire presence (% of samples)	20%
	Mean number ground fires/sample	1
	Mean fire interval (ground fires)	NA
	Known fire origin (% of samples)	0%
	Scarring effect on mortality	Varied

3.4.6 *Tsuga canadensis* (eastern hemlock)

Eastern hemlock is a species with many exceptional life history traits. This tree is the longest lived of any in the Acadian forest, sometimes enduring for as long as 800 years (Godman and Lancaster 1990). Across North America, no other tree species is as shade tolerant; suppressed hemlock seedlings and saplings can persist within the understory for as long as 400 years (Godman and Lancaster 1990). Across Nova Scotia, it's the only softwood species represented by extant pure stands of old growth forest (Lynds 1992, Lynds and LeDuc 1993), although the stands are few in number.

The rarity of old growth hemlock forest stems, in part, from the exacting conditions the species requires for successful stand initiation and development (see Godman and Lancaster 1990 for review). Unfortunately, these conditions are not well understood. Little, if any, historical information exists particularizing the origins or development of present day old growth hemlock. This can be partly attributed to the species' longevity. Most old growth hemlock

stands were initiated before any of this region's first settlements or record books. Most new growth hemlock stands will easily outlive any researcher.

Hemlock is sometimes found in pure localized patches but usually mixes with *Pinus strobus*, *Picea rubens* and or the upland hardwoods (Saunders 1970, Farrar 1995). In Kejimikujik, sample sites included both very both pure and more heterogeneous, early and late seral stands (Table 21). Late successional sites were composed of large widely spaced trees with tight canopies, sparse understories, and very little ground vegetation (see Figure 30). Blow downs were common in these older growth stands, fallen trees opening up very large gaps in the canopy and allowing the proliferation of a flush of new recruits (Figure 30). Hemlock stands were sampled in both low and moderately sloped areas where soil types were typically well drained.

Fire was very apparent in Kejimikujik's hemlock forests, its evidence more easily detected than in any other stand type. Charcoal was found on many tree trunks and in all soil samples. Sometimes older

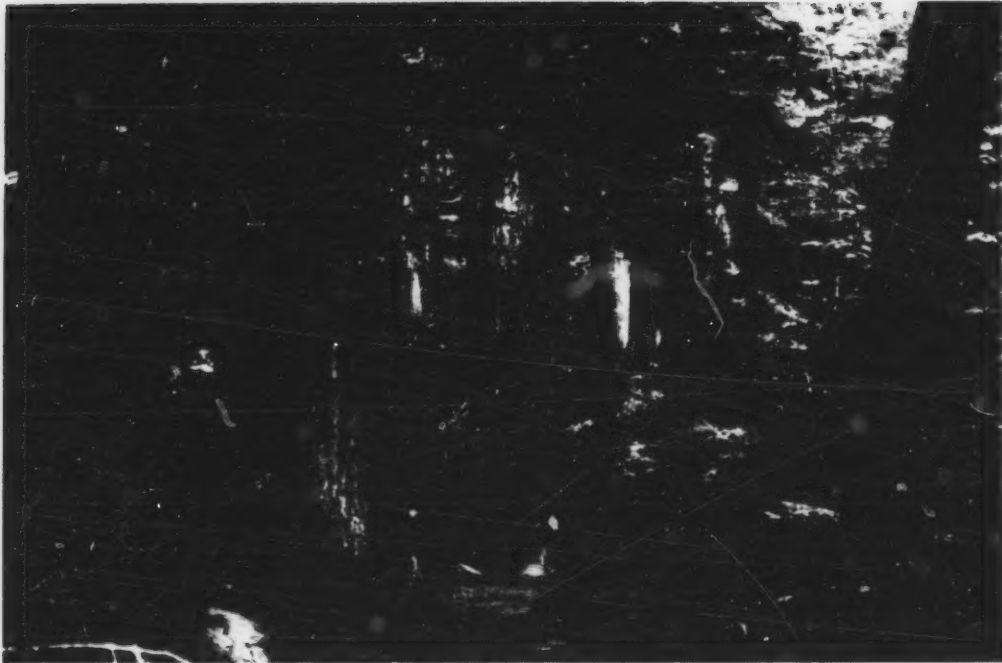


Figure 30. Photograph of a typical hemlock stand sampled from Kejimikujik National Park.

stems were scarred in several places. These scars were deep, similar to the pines, but rarely ran very high on the trunk (see Appendix P). Logging was apparent in the younger stands where old roads and the occasional rotting pine stem was found. In old growth areas, little indication of logging was detected.

Two relevant studies have been conducted to elucidate the role of disturbance in the hemlock forests of southwestern Nova Scotia. Taylor (1959) surveyed secondary successional communities in cut-over areas formerly dominated by old growth

hemlock. Hemlock remained a minor component up to twenty years after the harvest whereupon it was succeeded by other species (Taylor 1959). As hemlock is very shade tolerant, Taylor (1959) predicted it would outlive other recruits to eventually regain its dominance. Miles and Smith (1960) conducted a similar study in burned-over sites. They used tree ages and charcoal evidence to project stand successional and disturbance histories. Although conclusive evidence was not offered, Miles and Smith (1960) felt fire very likely has had a major role in initiating pure old growth hemlock stands.

This study's findings do not substantiate overstory fire's role in initiating hemlock stands. Our sample sites were all unevenly aged. Data from most other studies lend similar support (see Carey 1993c for review). Rogers (1978) for example felt most even-aged stands, that others presupposed were fire-origin, probably were actually unevenly aged. Hemlock is also a light intolerant species; germination usually occurs under a thick overstory (Godman and Lancaster 1990) unlike the growth conditions left after most fires.

Our data do show that understory fire has had a significant place in the history of KNP's hemlock stands and very likely played a role in their maintenance. Fire scarred trees were found in every hemlock stand sampled. Godman and Lancaster (1990) and Carey (1993c), in their reviews of the species' silvics, have offered empirical evidence to support fire's role in shaping such stands. Stands without surface fire, and or another scarifying agent, show far poorer recruitment rates (Godman and Lancaster 1990, Carey

1993c). Such stands are unlikely to persist as seral hemlock.

Our findings contradict Gimbarzevsky (1975), as he noted fire's absence from old growth hemlock stands. Martin's (1956) reports the absence of hemlock regeneration in recently burned-over old growth stands, although his findings were based on insufficient data and did not allow for a sufficient time lag following the burn.

Prescribed understory fires have been used to promote recruitment in older hemlock stands (Godman and Lancaster 1990). Fire serves to scarify the forest floor, exposing inorganic nutrients and ensuring successful germination. Larger hemlock stems are quite flame tolerant (Godman and Lancaster 1990, Carey 1993c) allowing them to persist through each blaze, and with the species' delayed senescence, effectively outliving and out-competing most other species.

Table 21. Outline of the quantitative and qualitative attributes of hemlock study stands. See appendix A for list of species acronyms and Latin binomials. Mean percentages of dominant and subdominant canopy trees were calculated using coverage values measured across all sample plots. Mean densities of regenerating tree species are given in stems/hectare and basal area (square meters/hectare); mean abundance of non-tree species is given as percent cover. The effect of fire scarring on mortality was subjectively indexed from fire-scarred basal cross-sections and canopy condition (see appendix C). (na - not available; dbh - diameter at breast height; GIS - geographic information system; KNP - Kejimikujik National Park; n - sample size; NA - not applicable/available; ha - hectares; m - meters; cm - centimeters)

Stand type	Hemlock (n=5)	Data
Canopy composition	Dominant species - GIS	68% (He)
	Dominant species - field data	80% (He)
	Subdominant species 1 - field data	8% (rO)
	Subdominant species 2 - field data	8% (He)
Subcanopy composition	Dominant species - field data	100% (He)
Physiography	Number stands in KNP	105
	Mean area	6.7 ha
	Combined area	427.0 ha
	Proportion (%) of study area	5.9%
	Proportion (%) of KNP's forests	1.5%
Overstory structure	Mean height	23.6 m
	Mean dbh	38.5 cm
	Mean age	107.2 ± 40.5 years
	Density	97.6 ± 4.8%
Understory structure	Dominant species #1	rM (51000/ha; 0.04 m ² /ha)
	Dominant species #2	He (17500/ha; 0.62 m ² /ha)
	Dominant species #3	others (≤ 5000/ha; 0.37 m ² /ha)
Herb and shrub layer (non-tree species)	Dominant species #1	moss spp. (56%)
	Dominant species #2	bracken fern (4%)
	Dominant species #3	mayflower (1.5%)
Fire history	Charcoal presence (% of samples)	100%
	Surface fire presence (% of samples)	100%
	Mean number ground fires/sample	4.4
	Mean fire interval (ground fires)	19.2 years
	Known fire origin (% of samples)	0%
	Scarring effect on mortality	minimal

3.4.7 *Quercus rubra* (red oak)

Red oak is the only oak species native to the Acadian forest. Like white pine, this tree was very heavily impacted by early logging activities (Johnson 1986). This history and its relatively slow growing nature have reduced the tree's abundance across the province (Roland and Smith 1969). Red oak is primarily an upland species found in pure and mixed stands (Sander 1990). Pure red oak stands are very rare in Kejimikujik comprising only 1.7 % of the study area (Table 22), though they are reported to be more common in

this part of the province that any other (Saunders 1970).

Homogeneity in sampled oak stands varied considerably. *A priori* selected sample sites were to contain at least fifty percent *Q. rubra*. Some of those sampled were virtually pure oak (not pictured), whereas others varied between thirty and forty percent across the stand. These stands were more representative of a hardwood dominated mixed community where oak is the main broad-leaf component (see Figure



Figure 31. Photograph of a typical red oak stand sampled from Kejimikujik National Park.

31). The more homogenous oak stands appeared relatively xeric, as compared with other hardwood assemblages, and supported high concentrations of less common grass species and the wood fern (*Dryopteris* spp.)(Table 22). The forest floor in these sites sometime appeared almost meadow-like (not pictured). Under the grass (Graminifolia), the organic layer was thick and dry, a mixture of decaying leaves, small twigs, and sometimes charcoal.

No evidence of tree harvesting was apparent in sampled oak sites. Fire scars were found in forty percent of samples, these being the purest, most even, and oldest of any the oak stands surveyed. It was not uncommon to find several scars clustered together, sometimes dozens at a time, all at the same aspect. Charcoal in the ground layer was also evenly stratified with soil horizons; strata were thick and dense with a uniform distribution.

There appears to be some discrepancy as to whether oak stand development is tied to fire. Sander (1990) underplays the role of fire in seedling establishment whereas Tirmenstein (1991) asserts its role is important. Rowe (1972), in his

classification of Canada's forests, placed much emphasis on fire's role in shaping eastern red oak stands as did Saunders (1970) and Johnson (1986) in their reviews of Nova Scotia's trees. In this province, and likely other areas of Acadian forest, fire has been found to promote red oak growth, producing sometimes pure stands or stands of oak mixed with *Betula papyrifera*, *Betula populifolia*, and or *Populus* spp.; this is substantiated by post-burn surveys conducted by Fernow (1912).

In this study, no fire-origin oak stands were found. This finding may be attributed in part to the conservative empirical method utilized to classify stand age structure or to the species tendency to produce uneven stands after stand replacing disturbance events (Sander 1990). This argument is supported by archival data collected after field surveys were completed. Forty percent of sample stands were located in areas where archival data revealed a burn history; these sites were the purest sampled. Other known burn sites in KNP were dominated by an even aged mixed forest of red oak, red maple, and white birch. Fire therefore does play a role in initiating both pure and mixed oak stands in Kejimikujik.

Table 22. Outline of the quantitative and qualitative attributes of red oak study stands. See appendix A for list of species acronyms and Latin binomials. Mean percentages of dominant and subdominant canopy trees were calculated using coverage values measured across all sample plots. Mean densities of regenerating tree species are given in stems/hectare and basal area (square meters/hectare); mean abundance of non-tree species is given as percent cover. The effect of fire scarring on mortality was subjectively indexed from fire-scarred basal cross-sections and canopy condition (see appendix C). (na - not available; dbh - diameter at breast height; GIS - geographic information system; KNP - Kejimikujik National Park; n - sample size; NA - not applicable/available; ha - hectares; m - meters; cm - centimeters)

Stand type	Red oak (n=5)	Data
Canopy composition	Dominant species - GIS	57% (rO)
	Dominant species - field data	58% (rO)
	Subdominant species 1 - field data	16% (rM)
	Subdominant species 2 - field data	14% (wP)
Subcanopy composition	Dominant species - field data	40% (wP)
Physiography	Number stands in KNP	22
	Mean area	5.6 ha
	Combined area	123.8 ha
	Proportion (%) of study area	1.7%
	Proportion (%) of KNP's forests	0.4%
Overstory structure	Mean height	17.9 m
	Mean dbh	26.3 cm
	Mean age	84.6 ± 24.7 years
	Density	92.0 ± 4.8 %
Understory structure	Dominant species #1	wP (188000/ha; 0.35 m ² /ha)
	Dominant species #2	rM (172000/ha; 0.24 m ² /ha)
	Dominant species #3	rO (10000/ha; 0.01 m ² /ha)
Herb and shrub layer (non-tree species)	Dominant species #1	<i>kalmia</i> (20.8%)
	Dominant species #2	bracken fern (16%)
	Dominant species #3	grass spp. (9.5%)
Fire history	Charcoal presence (% of samples)	100%
	Surface fire presence (% of samples)	40%
	Mean number ground fires/sample	4.5
	Mean fire interval (ground fires)	8.6 years
	Known fire origin (% of samples)	0%
	Scarring effect on mortality	minimal

Fire scars were found in forty percent of sample stands, as mentioned above, these being the oldest and most homogenous. As *Quercus rubra* has a known tolerance of fire and post-fire cambium damage (Tirmenstein 1991), understory fire likely plays an important role in promoting successful red oak self-seeding and in maintaining stand purity for this species. Continued fire suppression will likely reduce the frequency if not eliminate red oak dominated stands from the park.

3.4.8 *Betula papyrifera* (white birch)

White birch is primarily a boreal species, though its range extends well into parts of the mountain cordillera, St. Lawrence Lowlands, and Acadian forest regions, amongst others (Rowe 1972). This fast growing tree grows best on well drained sandy loams (Safford et al. 1990) and commonly mixes with other birches, *Pinus* spp., *Picea* spp., *T.canadensis*, *Populus*

spp., *Acer* spp., *Abies balsamea*, *Q. rubra*, and *Prunus* spp..(Farrar 1995). In recently harvested or burned areas, white birch will quickly establish dominance often forming pure stands (Saunders 1970, Safford et al. 1990, Farrar 1995).

Different types of white birch dominated stands were encountered in this study. The first was heavily dominated by birch and mixed with either white pine, hemlock, or sugar maple/beech (not pictured); in this forest type very little understory was found, though white pine and occasionally beech were relatively abundant in the ground layer. The second white birch dominated community was more evenly mixed with codominants such as *Populus* spp., wire birch (*Betula populifolia*), and or red oak (see Figure



Figure 32. Photograph of a typical white birch stand sampled from Kejimikujik National Park.

32); here the understory of white pine, balsam fir, and red maple was thicker and further developed.

Little logging evidence was found in the white birch sampling sites though all were located in highly accessible areas where harvesting undoubtedly occurred. Sixty percent of sample stands originated with a known fire event, the same sixty percent also containing evidence of surface fire. These stands were the oldest, purest, and most even of those sampled; they were also quite similar to the fire shaped stands of hemlock, red pine, and red oak in that their understories were relatively free of

saplings and dense numbers of herbaceous and woody shrubs. Fire appears to play a role in creating and or maintaining this dichotomy of structure and composition.

White birch is highly intolerant of fire (see Uchytel 1991a for review). Its bark is thin leaving the underlying cambium prone to injury. It is quite common to see dead trees twisted about a severe burn wound. White birch is also a great disperser, shade intolerant, and capable of resprouting from cut or burnt stumps making it a highly successful post-burn species (Safford et al. 1990). White birch recovers quickly after a fire (Uchytel 1991a).

In the boreal and mixedwood regions, where white birch thrives, forests burn at fifty to 150 year intervals (Uchytel 1991a). According to Saunders (1970) however, the species is known amongst native peoples as one which rarely if ever is stuck by lightning. White birch dominated sites are not particularly flammable, often stopping a running crown fire or reducing it to a surface fire intensity (Uchytel 1991a). Despite their poor fire resistance, the low flammability of *B. papyrifera* sites often saves larger stems, allowing their retention as seed trees (Uchytel 1991a). It is not difficult to find viable trees with severe scars. Such appears to be the case in KNP where pure post-fire sites were successively burned by likely very low intensity surface fire. Here larger trees survived, providing recruits, and allowed for the maintenance of stand composition. Evidence of understory fire was found in sixty percent of samples.

3.4.9 *Acer rubrum* (red maple)

In Nova Scotia, red maple is the most common hardwood species (Saunders 1970). Although it grows best in moist areas, red maple does well in a variety of sites and is common throughout the Acadian range (Rowe 1972, Farrar 1995). Red maple is considered shade tolerant but often dominates post-disturbance communities and can maintain overstory dominance in late successional stands (Walters and Yawney 1990). More often, red maple is found mixed with other species in mid-successional stages.

In the twenty-five years since Gimbarzevsky's (1975) database was compiled, red maple communities have undergone considerable change in structure and composition. This shift was most apparent in upland and boggy sites (see Figure 33), less so in the lakeside flood plains (not pictured).

Table 23. Outline of the quantitative and qualitative attributes of white birch study stands. See appendix A for list of species acronyms and Latin binomials. Mean percentages of dominant and subdominant canopy trees were calculated using coverage values measured across all sample plots. Mean densities of regenerating tree species are given in stems/hectare and basal area (square meters/hectare); mean abundance of non-tree species is given as percent cover. The effect of fire scarring on mortality was subjectively indexed from fire-scarred basal cross-sections and canopy condition (see appendix C). (na - not available; dbh - diameter at breast height; GIS - geographic information system; KNP - Kejimikujik National Park; n - sample size; NA - not applicable/available; ha - hectares; m - meters; cm - centimeters)

Stand type	White birch (n=5)	Data
Canopy composition	Dominant species - GIS	na (wB)
	Dominant species - field data	64% (wB)
	Subdominant species 1 - field data	8% (wP)
	Subdominant species 2 - field data	6%(sM)
Subcanopy composition	Dominant species - field data	27% (sM)
Physiography	Number stands in KNP	8
	Mean area	6.6 ha
	Combined area	52.5 ha
	Proportion (%) of study area	0.7%
	Proportion (%) of KNP's forests	0.2%
Overstory structure	Mean height	18.8 m
	Mean dbh	20.0 cm
	Mean age	85.4 ± 21.7 years
	Density	96.3 ± 4.8%
Understory structure	Dominant species #1	rM (350000/ha; 0.73m ² /ha)
	Dominant species #2	wP (150000/ha; 0.89 m ² /ha)
	Dominant species #3	bF (251667/ha; 0.26 m ² /ha)
Herb and shrub layer (non-tree species)	Dominant species #1	moss spp. (25.3%)
	Dominant species #2	<i>kalmia</i> (11.3%)
	Dominant species #3	grass spp. (7%)
Fire history	Charcoal presence (% of samples)	80%
	Surface fire presence (% of samples)	60%
	Mean number ground fires/sample	4.3
	Mean fire interval (ground fires)	13.4 years
	Known fire origin (% of samples)	60%
	Scarring effect on mortality	average to severe



Figure 33. Photograph of a typical red maple stand sampled from Kejimikujik National Park.

The two types of red maple stands encountered (flood plain and moist upland/bog sites) had different physiognomies, different understories, and different geophysical attributes. The flood plain sites were dense with a large proportion of red maple and a strong association with heath plants like *Rhodora*, labrador tea (*Ledum groenlandicum*), leather leaf (*Chamaedaphne calyculata*), sweet gale (*Myrica gale*) and grass species. All other red maple stands were juxtaposed next to poorly drained sites where black spruce prevailed. These stands were mixed with

white pine and larch, and had understories of black spruce or balsam fir.

Few indications of historic logging were found during sampling. Fire scars were found in eighty percent of sample sites though infrequently on a red maple tree. Forty percent of samples showed strong fire-origins, these being the flood plain sites.

Red maple is intolerant of fire (Tirmenstein 1991). Even moderate intensity burns will kill mature trees. Fire can however serve to stimulate red maple

growth, allowing for its dominance in early successional communities (Walters and Yawney 1990); the species has highly viable seeds and an excellent sprouting ability. Across the Acadian forest, red maple has been documented in several burned areas (Roland and Smith 1969, Saunders 1970, Rowe 1972, Stanley et al. 1973). In Kejimikujik, continued fire suppression may decrease the incidence of single-species single-cohort red maple stands.

Evidence of understory fire was found in flood plain sites. It is, however, unlikely these burns play a strong role in maintaining red maple stand structure. Fire is uncommon in flood plains where the periodic influx of water reduces its likelihood (Walters and Yawney 1990). If the flood sites burned, red maple would return, as it has in the past. However, it is the regular reoccurrence of flooding not fire that maintains these sites. Red maple

is very well adapted to the biophysical conditions of alluvial plains (Walters and Yawney 1990). Colonial farmers often burned these sites to promote meadow hay production thus accounting for their abundant fire evidence.

In the other sampled red maple sites, understory fire would likely kill most maple stems and give the co-dominant black spruce or pine improved opportunities for establishment. In the absence of fire these sites are expected to shift to a mixture of *Picea* spp., *Pinus strobus*, *A. balsamea*, and red maple.

3.4.10 Forest successional patterns

Forest successional predictions for all study stand types are summarized in Table 25.

Table 24. Outline of the quantitative and qualitative attributes of red maple study stands. See appendix A for list of species acronyms and Latin binomials. Mean percentages of dominant and subdominant canopy trees were calculated using coverage values measured across all sample plots. Mean densities of regenerating tree species are given in stems/hectare and basal area (square meters/hectare); mean abundance of non-tree species is given as percent cover. The effect of fire scarring on mortality was subjectively indexed from fire-scarred basal cross-sections and canopy condition (see appendix C). (na - not available; dbh - diameter at breast height; GIS - geographic information system; KNP - Kejimikujik National Park; n - sample size; NA - not applicable/available; ha - hectares; m - meters; cm - centimeters)

Stand type	Red maple (n=5)	Data
Canopy composition	Dominant species - GIS	na (rM)
	Dominant species - field data	58% (rM)
	Subdominant species 1 - field data	12% (bF)
	Subdominant species 2 - field data	6% (bS)
Subcanopy composition	Dominant species - field data	53% (bF)
Physiography	Number stands in KNP	161
	Mean area	7.7 ha
	Combined area	1242.6 ha
	Proportion (%) of study area	17%
	Proportion (%) of KNP's forests	4.3%
Overstory structure	Mean height	15.6 m
	Mean dbh	27.6 cm
	Mean age	67.5 ± 30.1 years
	Density	91.8 ± 4.8%
Understory structure	Dominant species #1	rM (170000/ha; 2.35 m ² /ha)
	Dominant species #2	wP (40000/ha; 0.94 m ² /ha)
	Dominant species #3	bS (30000/ha; 0.05 m ² /ha)
Herb and shrub layer (non-tree species)	Dominant species #1	moss spp. (31%)
	Dominant species #2	low-bush blueberry (9%)
	Dominant species #3	bracken fern (9%)
Fire history	Charcoal presence (% of samples)	80%
	Surface fire presence (% of samples)	60%
	Mean number ground fires/sample	4
	Mean fire interval (ground fires)	26 years
	Known fire origin (% of samples)	40%
	Scarring effect on mortality	severe

Table 25. Summary of the successional patterns predicted for each study stand type with and without continued fire suppression. Species are listed in decreasing order of abundance where more minor components or isolated pockets are indicated in parentheses. See appendix A for list of acronyms used to describe tree species.

Current Composition	Future sere		
	Continued fire suppression	Without overstory fire suppression	Without understory fire suppression
White pine	Trend towards mixed softwood; wP, rS, bF (rM)	White pine stands initiated	White pine crown homogeneity and recruitment both promoted.
Red pine	Red pine stands lost; replaced by rS (bS, bF)	Red pine stands initiated	Red pine crown homogeneity and recruitment both promoted.
Red spruce	Structure maintained; rS, bF, rM	Trend towards existing red spruce stands possibly with higher percentage of wP	wP regeneration promoted
Black spruce	Structure maintained but fewer new stands initiated	Black spruce stands initiated	Uncertain; likely bF and rM less favoured
Mixed softwood	Structure maintained; possible trend towards pure rS, bF, He mix	Will vary depending on seed sources	He favoured, hardwoods possibly selected out
Hemlock	Uncertain (insufficient data with this long-lived species)	Uncertain (inconclusive data); some stands possibly initiated	Pure He stands maintained
Red oak	Shift to mixed wood, dominated by wP, rO, and rM	More rO stands likely initiated	Existing and future stands of red oak maintained
White birch	Few if any wB stands initiated; current stands replaced with mixed wood (wP, sM, rM) or pure hardwood (sM, Be, wB)	Some stands initiated	Pure white birch maintained where surface fires are not too intense
Red maple	rM homogeneity promoted in existing stands	Some rM stands initiated	Shift to wP (bS, bF)

3.5 Fire in the landscape - synthesis

The majority of fire ecology research on North America has been conducted outside the northeastern part of the continent, the Acadian region in particular. The fires in the Acadian forest are usually smaller, less intense, and less frequent than in other ecoregions (Van Wagner 1988).

Consequently, researchers have not been able to collect good fire history data or have concluded that fire does not play significant enough an ecological role to warrant its research. Acadian forests are also complex, marked by relatively high tree species diversities (Rowe 1972), unstable climatic influences (Phillips 1990), and a long history of human occupation (Harvey 1936). Such attributes have impeded efforts to pinpoint fire's role and to derive a theory to describe the ecoregion's forest dynamics.

The Acadian forest extends through most of maritime Canada (Rowe 1972) and a large part of the State of Maine as parts of both the Laurentian and Adirondack-New England mixed forests (Bailey 1995). The area's relatively moist cool climate and infrequency of dry lightning events effectively lowers its predisposition for

wildfire. Droughts do occur though (Phillips 1990, Briggs and Lemin 1992) and with the droughts, occasional large fire events. Lorimer (1977), in summarizing fire reports by Morse (1819), Loring (1880), Cary (1884), Perley (1891) and Coolidge (1963), documents the occurrence of several large scale fires, some upwards of 32 000 hectares in area, across the State of Maine. Similarly in Canada, Wein and Moore (1977) indicate the occurrence of very large fires in the Acadian region, quoting the 2 000 000 hectare 1825 Great Miramichi Fire as example (see section 3.2.2; Wein and Moore 1979 for additional review of historical literature). Although, these syntheses have provided evidence of large-scale post-colonial fires, they also clearly indicate the difficulty in separating historic anthropogenic and lightning ignitions. Neither Lorimer (1977) or Wein and Moore (1977, 1979) determined the natural fire regime of the Acadian forest.

Preserved pollen and charcoal analyses have been successfully used to explore the role of fire in maintaining the long term stability and change of northeastern forest communities (e.g. Davis 1961,

Heinselman 1973, Green 1976, 1981, 1982, Anderson et al. 1986, Strang 1972, Wein et al. 1987). In southwestern Nova Scotia for example, Green (1981, 1982) indicates the prevalence of large intense fires from 11 000 to 6000 years before present (BP) and a resultant instability in forest community composition. By approximately 4000 years BP, the composition of Acadian species had stabilized and likely resembled what is seen today (Green 1982). During the period 4000 – 0 years BP, fire size and abundance likely decreased, though regular fires still contributed significantly to community stability and change (Green 1981).

Green's (1981, 1982) interpretation of lake sediment pollen data is supported by Strang (1969, 1972) who conducted a similar analysis on bog sediment cores, taken approximately 60 kilometers southeast, in an area of extensive heath barrens first noted by Smith (1802) and mapped by Fernow (1912). In this area, soils are poorer, heavily loaded with rocky debris, and dominated by a mix of ericaceous species; only small stunted trees are present. Strang (1972) indicates that soil conditions and periodic burnings

have maintained the area as a series of barrens since approximately 2000 BP when the cover type was first established by climate change.

Some evidence exists to show the fire barrens of southwestern Nova Scotia have shrunk since they were surveyed by Fernow (1912). In the Tobeatic region, just southwest of KNP, many of the barrens have partially or fully restored forest cover (MacLean 1975). The two small remnant fire barrens Stanley et al. (1973) identified in Kejimikujik have almost totally disappeared at present day. A possible explanation lies with the area's history of human occupation and influence. In the past two hundred years, anthropogenic ignitions likely improved growth conditions for barren species, thus promoting their spread and offering explanation for their widespread prevalence during Fernow's (1912) provincial survey. With the advent of modern fire fighting technologies thirty to forty years ago however, reduced fire frequencies have decreased the competitive edge heath plants have in post-fire environments, allowing for better tree species colonization, and initiating a decrease in barren size.

The evidence from Green (1981, 1982) and Strang (1969, 1972) illustrates several ecological features of southwestern Nova Scotia: 1) lightning fires occurred with regular periodicity prior to European colonization; 2) European settlers increased regional fire size, intensity, and frequency and changed the forest ecology of the area; 3) prior to the implementation of modern fire control techniques, lightning fire had significant influence on forest community composition, change, and stability; 4) fire suppression has changed the forest ecology of the area; 5) fire was needed to maintain the dynamic equilibrium of growth, retrogression and renewal found in precolonial forests.

This study compliments research conducted by Green (1976, 1981, 1982) and Wein and Moore (1979). Unlike Wein and Moore (1979), this study separated lightning and human fires from fire regime estimates and aimed to determine the influence of fire on individual tree species. Dendrochronology data from fire scarred trees was used to determine point fire frequencies. Unlike Green's (1976, 1981, 1982) research, this study did not focus on differences in fire regimes over broad geographic scales and

over long multi-century time frames. A finer scaled approach was utilized to improve understanding of fire ecology within time frames and geographic scales having functional relevance to the forest itself.

Kejimikujik National Park lies in the interior of southwestern Nova Scotia, an area known for its abundance of lightning fires (Wein and Moore 1979) and long periods of *high* (sensu Van Wagner 1974) fire weather (Simard 1973). A wealth of written material indicates the area's long fire history (see section 3.3; Johnson 1986), previous field surveys documenting its ecological significance (e.g. Loucks 1962, Rowe 1972, Johnson 1986).

Kejimikujik also lies in one of the less anthropogenically impacted regions of the province; the area was settled later than most other locales and did not lend itself well to travel outside its main waterways. Kejimikujik's status as a national park has also ensured to minimize human stresses for the past thirty-five years.

This study's results indicate the Kejimikujik forest landscape has been heavily influenced by wildfire. Data show a relatively high incidence of both

overstory and understory fires. Historic overstory fires were on average small but relatively frequent. The calculated fire cycle of 78 years differs from similar rotational indices calculated by other researchers for the province at large. Wein and Moore (1979) used Fernow's (1912) data to derive a rotational period of 200 years for the pre-suppression era and using provincial fire reports a period of 1000 years for the time frame that followed. Using lake sediment data, Green (1976) predicted a return interval of 400 years. Mooney et al. (1978), in their review of North American fire regimes, estimated a rotational period of 100 years for the many boreal inclusions found throughout the Acadian range but did not address similar inclusions from the northern hardwoods-hemlock-pine zone (*sensu* Braun 1950) of the south.

The fire regime of the Acadian forest appears to vary dramatically throughout its range. Throughout both New Brunswick (Wein and Moore 1977) and Nova Scotia (Wein and Moore 1979), twentieth century data was used to estimate return intervals for various physiographic zones classified in Loucks (1962). A return interval of 2000 years was found for the red spruce-

hemlock-pine and 1800 for the sugar-maple-hemlock-pine zones found in the Kejimikujik region. This contrasted strongly with similar estimates Wein and Moore (1979) found using pre-suppression data derived from Fernow (1912). Similar to this study's rotational calculations, Wein and Moore (1979) estimated pre-suppression return intervals of 66 years for the red-spruce-hemlock-pine zone and 158 years for the sugar-maple-hemlock-pine.

Preliminary research on isolated stands throughout the Acadian range has also revealed a range of fire frequencies. A fire rotational period of 60 years has been estimated for black spruce dominated stands in northeastern New Brunswick (Maclean and Wein 1977), 65-70 years for *Pinus banksiana* stands in Cape Breton Highlands National Park (Williams 1992), and 210 years for forests of Kouchibouguac National Park (Crossland 1996). Lorimer (1977) documents the occurrence of multiple fires in the life span of spruce-fir forests in north-central Maine.

The pre-colonial fire regime of Kejimikujik is not known. Existing pollen analysis technologies do not allow for the type of

very fine scale spatio-temporal resolution that is needed. The majority of extant stands are too young to provide accurate indication of pre-colonial disturbance forces. However, Kejimkujik lies within a belt where fires are ignited more often than most other areas of Acadian forest. Pre-colonial fire regimes were likely longer than calculations outlined in this study but far shorter than similar indices given in Wein and Moore (1979).

An understory fire return interval of 25 years was found for Kejimkujik National Park. There is no data from other areas of the Acadian region to compare this frequency with. However, historic fire weather data can be used to verify the probability of understory fire. In the *high* fire weather zone Kejimkujik falls within (Simard 1970), Van Wagner (1974) predicts most burns will not exceed understory intensity status. In pre-colonial Kejimkujik, moderate and hot understory burns were likely common though their recurrence rate is unknown.

The park's mixed severity fire regime has strongly shaped the structure of its forests. Like much of the forest in southern Maine (see Bailey 1995), the pine-hemlock-

spruce forests of Keji have a relatively strong relationship with fire. Red spruce and hemlock are more common in the sites which escaped hot fire. Single species stands of red oak, white birch, red maple, black spruce, or pine and mixed stands of oak, maple, birch, and sometimes aspen are more common in the sites that did not. In the absence of stand-replacing fire, most forests will revert to a gap-replaced community of primarily pine and red spruce; some pure hemlock stands will persist in the moister areas, black spruce in the very moist. Future understory fires would likely regress late successional pine/spruce communities to an earlier seral stage of pure pine or a pine-hardwood mix.

In the absence of fire, many of the hardwood stands in Kejimkujik's sugar maple-hemlock-pine zone will likely progress to a late-successional mix of sugar maple, beech, and yellow birch. Fire in the stands is predicted to promote a mixed community of maple, oak, and birch. Understory fire is predicted to favour red oak, possibly white birch, and possibly red maple.

4.0 Management Implications

As far as the forest is concerned, fire is neither good or bad, it just is. Fire has been a major force driving the dynamics of forests for millions of years. The recent human influence on fire frequency, duration, and size has not changed fire's role in the forest, it's only changed how and when that role is expressed. Fire is just one of many disturbance forces shaping forest development and change. Multiscalar disturbances such as fire, flooding, predation, death and birth all contribute to the dynamic nature of these ecosystems. Forests grow and shrink, shift and evolve with the abiotic and biotic fluctuations intrinsic to their nature. Environmental disturbances do not impact the forest negatively, they are a part of the forest. In their absence, certain species and groups of species, adapted to each disturbance's temporal and spatial scale, could be lost or threatened. Forests without fire will change at a rate and in a direction incongruent with their historic path of development.

The National Parks Act (1989) requires national parks protect and maintain both ecosystem structure and function. This means ecosystem managers must strive to

protect a system that is, by nature, in flux. The real challenge is to preserve or mimic the type, rate, and intensity of ecological change that would be present with very little human impact. In some instances, nature can simply be allowed to take its course but in the majority of cases, extrinsic forces such as pollution, transboundary flows, and public pressures serve to skew ecological processes and alter system dynamics. The issue of fire and its ecological role epitomizes this challenge.

Parks Canada has been actively fighting to control fires for sixty years (Parks Canada 1989). The irony is that many ecosystems they have sought to protect from fire are actually fire adapted (Woodley 1995). In other words, removing fire disturbances from these systems has shifted the intrinsic dynamic having evolved to maintain their integrity. As such, many national parks under the influence of fire suppression no longer are representative of the landscapes they were established to protect. In recent years, this realization initiated a shift in attitude and created a movement among ecologists. Parks Canada's ecosystem managers have proceeded to develop a new relationship with fire, striving to

protect people and surrounding properties while restoring fire's role in maintaining the renewal and health of Canada's national parks (Woodley 1995).

Since it was declared in 1968, Kejimikujik National Park has been following a policy of fire exclusion. All fires have, and continue to be, actively suppressed regardless of their location or origin. This policy, in the long term, will have major implications for the way that the forests of Kejimikujik develop. Some forests types will be eliminated totally whereas the species composition of others will change markedly. This study has demonstrated that the current structure and composition of Kejimikujik's forests is largely the result of fire. Fire suppression is changing the nature of Kejimikujik's forests; continued fire suppression will alter their future path of succession and development.

Parks Canada has a policy of maintaining ecological integrity. This policy is structured to ensure the subsistence of ecological processes such as fire. Parks Canada's Guiding Principles and Operations Policies (1994) states the following:

3.2.3

National park ecosystems will be managed with minimal interference to natural processes. However, active management may be allowed when the structure or function of an ecosystem has been seriously altered and manipulation is the only possible alternative available to restore ecological integrity.

3.2.4

Provided that park ecosystems will not be impaired, the manipulation of naturally occurring processes such as fire, insects and disease may take place when no reasonable alternative exists and when monitoring has demonstrated, that without limited intervention:

- i) there will be serious adverse effects on neighbouring lands; or*
- ii) major park facilities, public health or safety will be threatened; or*
- iii) the objectives of a park management plan prescribing how certain natural features or cultural resources are to be maintained cannot be achieved.*

Fire is a natural process. As such, a possible first policy response for Kejimikujik would be to allow fire to occur, except where it may endanger lives, facilities, or neighbouring lands. However, in the Kejimikujik area the large majority of wildfire does have the potential to endanger people and property. Thus, a second policy of actively suppressing wildfire is a reasonable alternative. To be consistent with Park's Guiding Principles and Operations

Policies (1994) though, a policy of fire suppression must include active management to restore fire's role in the ecosystem. This is done commonly in National Parks through the use of prescribed fire. Prescribed fire is the intentional use of fire to meet specific management objectives. It is used both to restore fire-dependent ecosystems and to reduce fire hazards by managing fuels. Prescribed fires are planned in detail using sophisticated computer-based fire behaviour models and ecological inventories. They are conducted by teams of fire specialists and trained fire fighters. Public consultation is sought at various stages of the planning process. The use of prescribed fire is widespread in national parks, in other protected areas, and in forest management occurring outside protected areas. At present there are active prescribed fire programs in eighteen national parks.

The use of prescribed fire is laid out in Parks Canada Directive 2.2.4 (Parks Canada 1986) and the consultation document "Keepers of the Flame" (Parks Canada 1989). In considering the maintenance and protection of forest ecosystem integrity, there is no question of

whether or not prescribed fire should be used in Kejimikujik, there is only a question of where and how much. Fire exclusion is an active management intervention. The management decision concerning prescribed burning can be boiled to 2 questions:

- *Is fire an important historical disturbance in Kejimikujik's forests?*
- *If forest communities will be lost with a policy exclusion, where should fire be restored and at what frequency?*

Results from this study clearly indicate fire has had a significant role in Kejimikujik's history and that its prescribed use will be necessary to maintain some of the park's existing forest types. This study also provides the necessary information needed to guide park managers in developing an appropriate schedule for implementing an ecologically effective burn program. Prescribed fire is a safe management tool that complies with policy and is used across Canada and world wide.

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Appendix A – Latin binomials and species acronyms

1. Herbaceous understory species

Common name	Latin binomial (sensu Roland and Smith 1969)
Mayflower	<i>Epigaea repens</i> L.
Bunchberry	<i>Cornus canadensis</i> L.
Snowberry	<i>Gaultheria hispidula</i> (L.) Muhl.
Goldthread	<i>Coptis trifolia</i> (L.) Salisb.
Lady slipper	<i>Cypripedium</i> spp. L.
Tea Berry	<i>Gaultheria procumbens</i> (L.) muhl.
Partridge Berry	<i>Mitchella repens</i> L.
Cinnamon Fern	<i>Osmunda cinnamomea</i> L.
Royal Fern	<i>Osmunda regalis</i> L.
Clintonia	<i>Clintonia borealis</i> (Ait.) Raf.
Bracken Fern	<i>Pteridium aquilinum</i> (L.) Kuhn
Sarsaparilla	<i>Arilia</i> spp. L.
Wild Lily-of-the-Valley	<i>Mainanthemum canadense</i> Desf.
Twin Flower	<i>Linnaea Borealis</i> L.
Grasses	Graminieae
Hay scented fern	<i>Dennstaedtia punctilobula</i> (Michx.) Desv.
Wood Fern	<i>Dryopteris spinulosa</i> (O.F. Muell.) Watt
Violets	<i>Viola</i> sp.
White Violet	<i>Viola incognita</i> Brainerd.
Common Speedwell	<i>Veronica officinalis</i> L.
Mosses	Moss spp.
Tall White Aster	<i>Aster Umbellatus</i> Mill.
Indian Cucumber Root	<i>Medeola virginiana</i> L.
Star Flower	<i>Trientalis borealis</i> Raf.
Wild Strawberry	<i>Fragaria virginiana</i> Duchesne
Trillium	<i>Trillium</i> spp.
Poison Ivy	<i>Rhus radicans</i> L.
Rough-Stemmed Goldenrod	<i>Solidago puberula</i> Nutt.
Shinleaf	<i>Pyrola elliptica</i> Nutt.

Appendix A – Latin binomials and species acronyms

2. Woody understory species (shrubs)

Common name	Latin binomial (sensu Roland and Smith 1969)
Kalmia	<i>Kalmia angustifolia</i> L.
Labrador Tea	<i>Ledum groenlandicum</i> Oeder.
False Holly	<i>Nemopanthus mucronata</i> (L.) Trel.
Northern Wild-Raisin	<i>Viburnum cassinoides</i> L.
Huckleberry	<i>Gaylussacia baccata</i> (Wang.) K. Koch
Leather Leaf	<i>Chamaedaphne calyculata</i> (L.) Moench, var. <i>angustifolia</i> (Ait.)
Rhodora	<i>Rhodora canadense</i> (L.)
Sweet gale	<i>Myrica gale</i> L.
Low Bush Blueberry	<i>Vaccinium angustifolium</i> Ait.
Velvet-Leaf Blueberry	<i>Vaccinium myrtilloides</i> Michx.
Witch Hazel	<i>Hamamelis virginiana</i> L.
Beaked Hazel	<i>Corylus cornuta</i> Marsh.

3. Tree species - classification used in study

Common name	Latin binomial (sensu Roland and Smith 1969)	Acronym
White Pine	<i>Pinus strobus</i> L.	wP
Red Pine	<i>Picea resinosa</i> Ait.	rP
Red Spruce	<i>Picea rubens</i> Sarg.	rS
White Spruce	<i>Picea glauca</i> (Moench) Voss	wS
Black Spruce	<i>Picea mariana</i> (Mill.) B.S.P.	bS
Larch	<i>Larix laricina</i> (DuRoi) K.Koch	La
Hemlock	<i>Tsuga canadensis</i> (L.) Carr.	He
Balsam Fir	<i>Abies balsamea</i> (L.) Mill.	bF
White Ash	<i>Fraxinus americana</i> L.	wA
Trembling Aspen	<i>Populus tremuloides</i> Michx.	Ta
Large-Tooth Aspen	<i>Populus grandidentata</i> Michx.	LrA
White Birch	<i>Betula papyrifera</i> Marsh.	wB
Speckled Alder	<i>Alnus rugosa</i> (DuRoi) Spreng.	sA
Beech	<i>Fagus grandifolia</i> Ehrh.	Be
Red Oak	<i>Quercus rubra</i> L.	rO
Sugar Maple	<i>Acer saccharum</i> Marsh.	sM
Red Maple	<i>Acer rubrum</i> L.	rM
Mountain Maple	<i>Acer spicatum</i> Lam.	mM
Striped Maple	<i>Acer pensylvanicum</i> L.	stM
Serviceberry	<i>Amelanchier</i> spp.	Sb
Black Cherry	<i>Prunus serotina</i> Ehrh.	bC
Pin cherry	<i>Prunus pennsylvanica</i> L.f.	pC

Appendix A – Latin bionomials and species acronyms

4. Tree species - classification used in 1992 NSDNR forest inventory (NSDNR 1994)

Common name	Acronym
Spruce	S
Intolerant hardwood	IH
Other softwood	OS
Other hardwood	OH
Hemlock	H
Oak	O

Appendix B - Field data sheets

Kejimikujik Fire History Study - General Plot Information

Date / /97	Plot No.	UTME	UTMN
Photo No.	Slope Class	Aspect Class	Elevation

Data collected by _____

Canopy Trees (estimated from 10m x 10 m plot)
 Closure ____% Mortality ____%

Sample #	1	2	3	4	5
Tree Species	_____	_____	_____	_____	_____
% Cover	_____	_____	_____	_____	_____

Ground Vegetation (estimated from 10m x 10 m plot)

Sample #	1	2	3	4	Litter
Ground Species	_____	_____	_____	_____	_____
% Cover	_____	_____	_____	_____	_____

Forest Floor

Litter Type () Leaves () Needles () Loose () Compacted () Thickness ____cm

Drainage Class (1 to 5) _____

Ladder Fuels

Branches to Ground	Herbaceous Growth Height	Height to Live Crown
Yes () No ()	____m	____m

Surface Fuels

Description:	Fine Litter ____%	Branches ____%	Dead Boles ____%
Density:	Scattered (<25%) ()	Light (25-50%) ()	Heavy (>50%) ()
Decomposition:	Material Intact ()	Material Rotting ()	

Indicators of Stand Origin

Charcoal Present	Yes () No ()	Depth ____cm	Thickness ____cm
Fire Scars Present	Yes () No ()	Years from present ____	
Fire scar collected	Yes () No ()	Charred Stumps/Roots Present	Yes () No ()
Sample #	_____		

Notes (i.e. location of fire scar in stand, species, condition)

Appendix B - Field data sheets

Kejimikujik Fire History Study - Tree and Shrub Data

Plot No. _____

Covertypes Data - Tree Data

Canopy Tree	Species	Ht.	Ht. to Crwn.	Diam.	Age	Core #	Notes
1		___m	___m	___cm	___yrs		
2		___m	___m	___cm	___yrs		
3		___m	___m	___cm	___yrs		
4		___m	___m	___cm	___yrs		
5		___m	___m	___cm	___yrs		

Subcanopy Tree	Species	Ht.	Ht. to Crwn.	Diam.	Age	Core #	Notes
1		___m	___m	___cm	___yrs		
2		___m	___m	___cm	___yrs		
3		___m	___m	___cm	___yrs		

Comments:

Appendix B - Field data sheets

Shrub and Sapling Vegetation (from 2 m x 2 m plot)

	1	2	3	4	5
Species	_____	_____	_____	_____	_____
% Cover	_____	_____	_____	_____	_____

Plot 1 - shrub and sapling

Species	Diameter	Height	Condition

Plot 2 - shrub and sapling

Species	Diameter	Height	Condition

Appendix C - Sample site data card and explanation of evaluation criteria.

1. Description of criteria used to evaluate soil drainage classes (as cited in Strong et al. 1990).

Drainage Class	Description
1. Rapidly Drained	Soil moisture content seldom exceeds field capacity in any horizon, except immediately after water additions. Soils are free of gleying throughout the profile. Rapidly drained soils are commonly coarse-textured or on steep slopes.
2. Well-Drained	Soil moisture content does not normally exceed field capacity in any horizon (except possibly the C) for a significant part of the year. Soils are usually free of mottling in the upper 1 meter but may be mottled below this depth. B horizons, if present, are reddish, brownish or yellowish.
3. Moderately Well-Drained	Soil moisture in excess of field capacity remains for a small but significant period of the year. Soils are commonly mottled in the lower B horizon, if present, may be faintly mottled in fine-textured soils and in medium-textured soils that have a slowly permeable layer below the solum. In grassland soils, the B and C horizons may be only faintly mottled and the A horizon may be relatively thick and dark.
4. Imperfectly Drained	Soil moisture is in excess of field capacity and remains in subsurface horizons for moderately long periods during the year. Soils are commonly mottled in the B and C horizons and the Ae horizon, if present, may be mottled. the matrix generally has a lower chroma than in well drained soils on similar parent materials.
5. Poorly Drained	Soil moisture in excess of field capacity remains in all horizons for a large part of the year. The soils are usually very strongly gleyed. Except in high-chroma parent materials the B, if present, and upper C horizons usually have matrix colors of low chroma. Faint mottling may occur throughout.
6. Very Poorly Drained	Free water remains at or within 30 cm of the surface most of the year. The soils are usually very strongly gleyed. Subsurface horizons usually are very strongly gleyed, and usually are of low chroma with yellowish to bluish hues. Mottling may be present, but at depth in profile. Very poorly drained soils usually have a mucky or peaty surface horizon.

Appendix C - Sample site data card and explanation of evaluation criteria.

2. Slope and aspect classes (as cited in Strong et al. 1990).

Slope Class	Percent Slope	Slope Class	Percent Slope
1	< 2	5	16 - 30
2	2 - 5	6	31 - 45
3	6 - 10	7	46 - 60
4	11 - 15	8	> 60

Aspect Class	Range	Aspect Class	Range
1. North	337 - 22°	5. South	157 - 202°
2. Northeast	23 - 67°	6. Southwest	203 - 247°
3. East	68 - 112°	7. West	248 - 292°
4. Southeast	113 - 156°	8. Northwest	293 - 336°

3. Mortality (condition) classes used to describe overstory trees

1. less than 10% dead
2. 10- 15% dead
3. 50 -90% dead

Appendix D – Stand age structure

Age structure of trees sampled in each sample stand. Species acronyms are detailed in Appendix A. (na - not available)

Stand	Canopy Trees Mean±SD	Canopy Trees Structure	Subcanopy Trees Mean±SD	Stand Structure
bS1	72±2.55	even	43.00±20.52	Even
bS2	65.6±13.72	uneven	80.67±8.33	Multi
bS3	73.8±9.68	even	48.67±13.43	Tiered
bS4	77.2±24.52	uneven	44.00±7.81	Multi
bS5	45.4±16.64	uneven	44.00±10.44	Multi
He1	67.8±39.56	uneven	44.00±10.82	Multi
He2	108.6±27.13	uneven	71.67±20.26	Multi
He3	98±12.71	uneven	86.00±14.93	Multi
He4	114.6±18.84	uneven	84.00±8.66	Multi
He5	147.2±54.04	uneven	93.00±97.96	Multi
MS1	64.6±13.90	uneven	65.33±4.51	Multi
MS2	67.8±19.42	uneven	28.00±7.94	Multi
MS3	82±29.99	uneven	37.67±3.21	Multi
MS4	44±7.55	even	24.67±12.10	Even
MS5	86.4±41.92	uneven	40.67±7.23	Multi
rO1	96±25.76	uneven	52.00±17.52	Multi
rO2	102.8±33.04	uneven	40.67±19.35	Multi
rO3	81.6±12.46	uneven	28.67±8.50	Multi
rO4	69±21.27	uneven	23.67±0.58	Multi
rO5	73.4±16.13	uneven	56.00±25.12	Multi
rM1	54.8±13.72	uneven	37.00±5.20	Multi
rM2	53.8±8.81	even	53.67±3.21	Even
rM3	70±35.13	uneven	28.33±10.97	Multi
rM4	45.8±8.26	even	33.33±23.12	Even
rM5	113.6±15.96	uneven	52.67±25.42	Multi
rP1	65±7.58	even	103.3±104.0	Even
rP2	81.8±4.71	even	35.67±11.59	Tiered
rP3	63±9.70	even	49.00±16.37	Even
rP4	86.2±4.32	even	0.99±39.51	Even
rP5	79.6±3.65	even	63.33±7.23	Tiered
rS1	63±35.97	uneven	44.33±17.21	Multi
rS2	52.8±18.07	uneven	46.67±12.50	Multi
rS3	62.4±6.19	even	49.33±5.03	Tiered
rS4	40.2±7.98	even	33.33±4.62	Even
rS5	88.4±6.62	even	80.00±5.20	Even
wB1	112±10.93	even	71.33±36.91	Even
wB2	69±6.93	even	60.00±13.89	Even
wB3	85.2±11.28	even	51.33±9.02	Tiered
wB4	na	na	na	Na
wB5	72.75±24.28	uneven	48.00±13.08	Multi
wP1	47.4±3.78	even	34.67±8.08	Tiered
wP2	83.2±39.18	uneven	49.33±5.69	Multi
wP3	86.8±7.12	even	69.67±19.86	Even
wP4	148±6.16	even	38.67±16.77	Tiered
wP5	96±15.84	uneven	41.33±9.29	Multi

Appendix E - Understory tree densities

Comparison of mean understory tree densities (mean $\pm$ SD (averaged among 4 m² study plots), sum(n)) among sample stand types of Kejimikujik National Park. See Appendix A for acronyms.

Species	Sample Stand Type								
	bS	He	MS	rO	rM	rP	rS	wB	wP
<i>Acer pensylvanicum</i> L. (striped maple)									3.0 $\pm$ 0.0, 3(1)
<i>Acer rubrum</i> L. (red maple)	59.0 $\pm$ 70.4, 295(5)	10.2 $\pm$ 9.2, 51(5)	14.5 $\pm$ 14.5, 58(4)	34.4 $\pm$ 15.6, 172(5)	34.0 $\pm$ 24.6, 136(4)		52.5 $\pm$ 96.5, 209(4)	70.0 $\pm$ 1.4, 140(2)	22.7 $\pm$ 15.0, 68(3)
<i>Acer spicatum</i> Lam. (mountain maple)						12.0 $\pm$ 0.0, 12(1)		1.0 $\pm$ 0.0, 1(1)	
<i>Aibes balsamea</i> (L.) Mill. (balsam fir)			4.0 $\pm$ 2.8, 8(2)	1.0 $\pm$ 0.0, 2(2)	4.0 $\pm$ 0.0, 4(1)		10.5 $\pm$ 13.4, 21(2)	12.6 $\pm$ 1.7, 151(3)	
<i>Amelanchier</i> spp. (shadbush)	7.0 $\pm$ 0.0, 7(1)					2.0 $\pm$ 0.0, 2(1)	11.0 $\pm$ 0.0, 11(1)		
<i>Corylus cornuta</i> Marsh. (beaked hazel)				1.0 $\pm$ 0.0, 1(1)					
<i>Fagus grandifolia</i> Ehrh. (beech)		1.0 $\pm$ 0.0, 1(1)						3.0 $\pm$ 0.0, 3(1)	
<i>Hamamelis virginiana</i> L. (with hazel)			1.0 $\pm$ 0.0, 1(1)	3.5 $\pm$ 2.1, 7(2)				11.0 $\pm$ 0.0, 11(1)	7.0 $\pm$ 0.0, 7(1)
<i>Nemopanthes mucronata</i> (L.) Trel. (mountain holly)					1.0 $\pm$ 0.0, 1(1)				
<i>Picea glauca</i> (Moench) Voss (white spruce)		1.0 $\pm$ 0.0, 1(1)	3.5 $\pm$ 0.7, 7(1)	1.5 $\pm$ 0.7, 3(2)		4.0 $\pm$ 0.0, 4(1)		1.0 $\pm$ 0.0, 1(1)	2.0 $\pm$ 0.0, 2(1)
<i>Picea mariana</i> (Mill.) B.S.P. (black spruce)	6.5 $\pm$ 0.7, 13(2)				6.0 $\pm$ 0.0, 6(1)	7.0 $\pm$ 0.0, 7(1)		3.5 $\pm$ 0.7, 7(2)	
<i>Picea rubens</i> Sarg. (red spruce)			4.0 $\pm$ 0.0, 4(1)	1.0 $\pm$ 0.0, 1(1)		1.0 $\pm$ 0.0, 1(1)	5.0 $\pm$ 3.5, 20(4)		
<i>Pinus strobus</i> L. (white pine)		1.0 $\pm$ 0.0, 1(1)	5.0 $\pm$ 4.2, 10(2)	37.6 $\pm$ 37.5, 188(5)	8.0 $\pm$ 8.7, 24(3)		13.3 $\pm$ 9.5, 40(3)	30.0 $\pm$ 49.5, 120(4)	112.8 $\pm$ 151.8, 451(4)
<i>Populus grandidentata</i> Michx. (large tooth aspen)			1.0 $\pm$ 0.0, 1(1)						
<i>Prunus serotina</i> Ehrh. (black cherry)					1.0 $\pm$ 0.0, 1(1)				
<i>Quercus rubra</i> L. (red oak)		1.0 $\pm$ 0.0, 1(1)		2.0 $\pm$ 0.0, 4(2)					1.0 $\pm$ 0.0, 1(1)
<i>Tsuga canadensis</i> (L.) Carr. (eastern hemlock)		3.5 $\pm$ 3.3, 14(4)	8.0 $\pm$ 0.0, 8(1)						
<i>Viburnum cassinoides</i> L. (wild raisin)							1.0 $\pm$ 0.0, 1(1)		

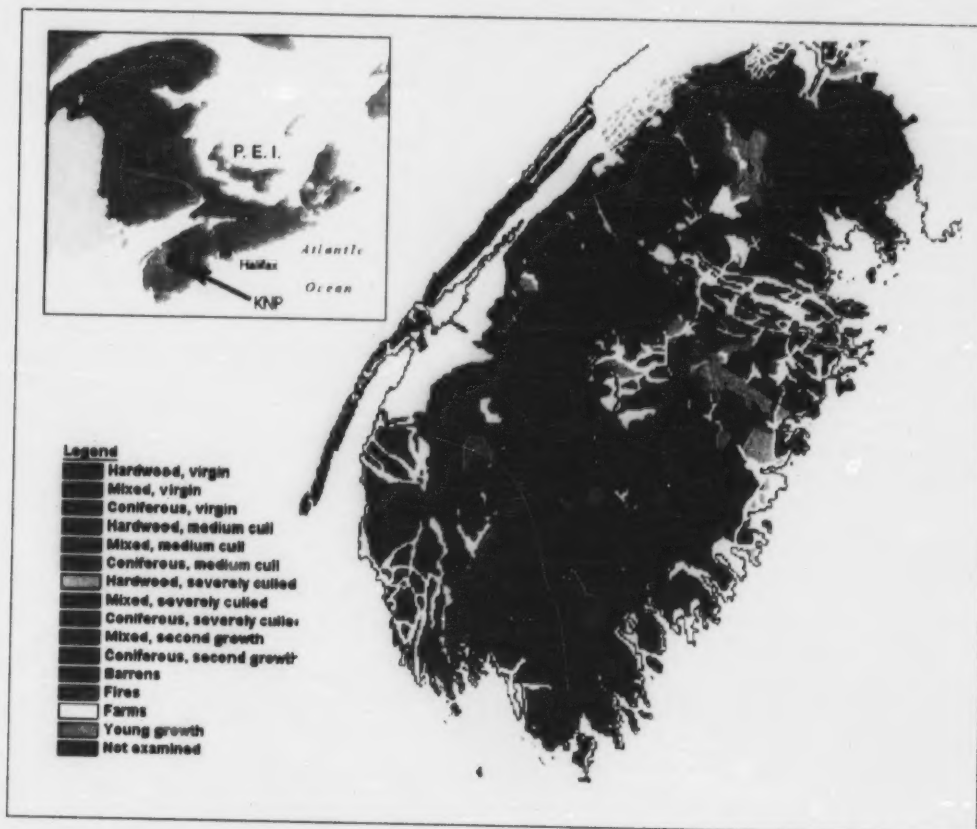
Appendix F – Stand origin data

Summary comparison of fire-origin and other origin sample stands. Included is a breakdown of physical attributes and a record of stand replacing fire history where applicable. (ID - identification, ha - hectare)(see Appendix A for outline of species acronyms)

Plot ID	Fire Origin Sites		Origin Date	Other Origin Sites		
	Area (ha)	Mean age		Plot ID	Area (ha)	Mean age
wP4	27.4	148	1849	bS2	2.3	65.6
wB1	2.2	112	1885	bS4	10.9	77.2
rS5	3.5	88.4	1909	bS5	3.6	45.4
rP4	4.7	86.2	1910	He1	7.1	67.8
wP3	50	86.8	1910	He2	145.8	108.6
wB3	10.9	85.2	1912	He3	22.6	98
rP2	7.3	81.8	1915	He4	14.1	114.6
rP5	1.2	79.6	1917	He5	38.2	147.2
bS3	9.1	73.8	1923	MS1	12.6	64.6
bS1	7.5	72	1925	MS2	52.7	67.8
wB2	13.4	69	1928	MS3	19.2	82
rP1	7.1	65	1932	MS4	13.8	44
rS3	1.2	62.4	1933	MS5	15.5	86.4
rP3	1.2	63	1934	rM1	48.9	96
rO2	14.5	53.8	1943	rM2	17.9	102.8
wP1	1.4	47.4	1949	rM3	11.3	81.6
rO4	26.2	45.8	1951	rM4	7.2	69
				rM5	15.4	73.4
				rO1	0.192	54.8
				rO3	15.7	70
				rO5	9.5	113.6
				rS1	185.8	63
				rS2	183.4	52.8
				rS4	9.6	40.2
				wB4	5.7	na
				wB5	7.7	72.75
				wP2	30.6	83.2
				wP5	30.2	96

Appendix G – Fernow's (1912) forest inventory of N.S.

Forest cover types in southwestern Nova Scotia circa 1908, 1909 (Fernow 1912). Kejimikujik National Park's (KNP) location is indicated on both Fernow's (1912) map and on the regional map of eastern Canada (see corner insert).



Appendix H - Fire reports from *The Gold Hunter and Farmers Journal*

<u>Date</u>	<u>Report</u>
1911, June 6	Forest fires are raging in many parts of the province. Several buildings and much valuable timber lands have been destroyed at Conquerall Bank by forest fires.
1913, Aug. 29	About 3000 acres of timberland near Mahone Bay was destroyed by the forest fires. The loss is estimated from \$75,000 to \$100,000.
1916, May 19	A fire started near the Eel weir last week and burned its way clear down the east side of the river and as far as Christopher Lake. A lot of valuable timber was destroyed. The sporting camp of P.H. Moore and other buildings at the landing were in danger, but the wind changed and saved the situation. A number of men were at work fighting the fire.
1918, June 7	Forest (sic) fires have done great damage in the Southern District. Five houses and two barns were destroyed at Beach Meadows, one house and two barns at Port Mouton. The fire is now under control. A very bad fire is raging at Dublin Shore, several houses and barns were burned and the fire is not yet under control.
1921, Sept. 9	Forrest fires have become very menacing during the last week. Large crews of men were to work trying to stop their progress, lack of water, however, making their task a hard one. The heavy rain Tuesday night put them under control. We understand that a few buildings on the McClair-Ford Mine at West Caledonia, were burned, and the men put to hasty flight. Not much damage was done to timber lands.
1929, May 17	Several forest fires did considerable damage in Western Nova Scotia on Monday, when a very high wind prevailed. One of them was on the right of way of the Foundation Co., between Milton and Brooklyn.
1929, June 28	Restrict Travel in the Woods. Menacing forests in all sections of the province, fire hazards have become so serious that the Department of Lands and Mines has prohibited all woods travel, except on permit, until August 21 or such time as rainfall lessens or eliminates such hazards, according to an announcement by Hon. W. L. Hall, Attorney General. This is the first time in the history of Nova Scotia, though the law has been on the statute books of the province for years, that the provisions are being invoked. (article continues)
1929, Aug. 23	Serious Conditions The forest fire situation is still extremely dangerous. This week a number of fires were burning throughout the whole Province, three fires set by the Dominion Atlantic Railway being fought and put out,

also several small fires around Halifax, and one nearer home at Channel Lake. The forest rangers are now fighting fires in Antigonish Co., and the situation in Cumberland County is very dangerous. In all, over 250 fires have been fought and put out this summer by the ranger force, burning 6,024 acres. Therefore it has been deemed necessary to extend the closed period for one month, and the Attorney General has issued a Proclamation accordingly. (article continues)

1930, May 16 New forest fires started in several districts of Nova Scotia on Monday and ranged at will over a wide area backed by a stiff breeze which taxed the most strenuous efforts of the fire-fighters. The main scene of operations against the onrushing flames changed, however, from Shelburne, though there are still menacing outbreaks there, to Yarmouth where, for a time the Argyles were endangered and where some of the most valuable timber in the province is being destroyed. (article continues – nearest fires to Kejimikujik area were Port Mouton where the railway had a gang of 50 men, three pumps and a yard engine working and on the Medway River near Port Medway which was reported under control)

Fires in the county are reported all out or under control.

I.L. Smart, as chief forest fire ranger for the Mersey Paper Co., has a busy job these days.

1930, May 23 Several motor parties have visited the fire zone of Southern Queens during the past week. The loss involved can only be realized by visiting the fire stricken area. The relief committee received a splendid donation from Northern Queens.

1930, June 13 On account of the extremely dry weather, the woods have again been closed. See proclamation.

1930, Aug. 15 Forests Again Closed (article continues – nothing on specific fires)

1932, May 27 A forest fire near Dean's Lake last week burned about 100,000 feet of pine timber owned by S. R. Bradley, of New York, and did some damage to timber owned by the Nova Scotia Woodenware Co. The fire had all indications of being set, not even caused by carelessness.

1937, May 7 A very serious forest fire raged at and near Port Medway on Tuesday. A large force of men and equipment finally got the fire under control.

Declaring the present fire hazard is one of the worst Nova Scotia has experienced in a long time, Attorney General J. H. MacQuarrie has issued a proclamation to close the forests and travel permits are now necessary for persons entering the woods.

1938, May 13 **Forest Fires** Two fires have occurred last week on lands owned by the Nova Scotia Woodenware lying between Westfield and Albany New. On Friday the fire spread over about 50 acres threatening extensive cuttings as well as 600 cords pulpwood and 100,000 feet of pine all yarded up. Sunday another fire broke out and burned over considerable territory of barrens or light growth before being controlled. George W. Wile, chief ranger, and C. E. Morgan, fire ranger, with fire fighting equipment, the fire engine from Caledonia and a large number of men were on the job. We understand the police are investigating.

Appendix I - Kejimikujik Oral History Interviews

James Morrison interviewed the following local residents, as reported in the Kejimikujik Oral History (KOH)(Parks Canada 1977):

- KOH 41 Mrs. Elton (Leona) Smith (nee Smart), age 85.
Born in 1892. Interview April 19, 1977. Leona Smith's husband, Elton, was an overseer with the responsibility of leading a crew of firefighters.
- KOH 81, KOH 102 Eric Millard, age 60.
Interview Aug. 5 and July 12, 1977. Eric Millard related that there were many woods fires from 1860 to 1900. He had read about them in surveyors' diaries, written at the time.
- KOH 86 Rev. A. G. McClare, age 81.
Interview April 6, 1977. Rev. A. G. McClare (KOH 86) talked about a large fire at the McClare-Ford mine in the summer of 1920 (no doubt the 1921 fire reported in *The Gold Hunter*).

Note: copies of tapes are held at the interpretive office of Kejimikujik National Park

Rick Swain (1998) interviewed the following local residents and compiled his results with those collected from earlier interviews made by Peter Hope and Millie Evans (interpreters at Kejimikujik). Notes from these interviews can be found in the files at the Interpretive Field Office of Kejimikujik National Park:

- Allen Rowter was interviewed at his home in Maitland Bridge on February 26, 1998, and on March 9, 1998. Allen was born in 1926. He logged with his father, Frank Rowter, and brother Tim. They logged in the Frozen Ocean area from 1949 to 1953 and between Little River and West River in 1947 and 1954. Locations of some of their logging activity are shown on the map in Appendix K. They also salvaged logs from Grafton Lake when the lake was drawn in 1951. Allen worked for Kejimikujik National Park from 1965 to 1991.
- Willis Forrest was interviewed at his daughter's home in West Caledonia on February 20, 1998 and on March 10, 1998. Willis was born in 1920. He first went to work in the woods when he was 12 years old. He worked for the Mersey (Bowaters-Mersey logging company) once, at Boot Lake in the Rossignol District, around 1933-34. Areas logged in Kejimikujik in the late 1940's and 1950's are shown on the map in Appendix K.

Appendix J – Bowater-Mersey fire records (Johnson 1952)

Date	Location	Area (acres)	Cause
1930	Brooklyn	8.5	rail way
1932	East Brook	63	hunters camp
1942	Porcupine Lake	8	lightening
	Roseway Lake	1000	lightening
1943	Port Joli	124	marsh burning
1944	Frog Lake	22	unknown
	?	1.5	unknown
1945	Sixth Lake	1.5	loggers
1946	Pescawess Lake	110	lightening
	Blankett Hill	15	berry pickers
1947	Keilly Lake	0.5	unknown
	Five Rivers	15	hunters
	Frog Lake	3	camp fire
	North Kemptville	4	unknown
	Forest Glen	2	incendiary
	Forest Glen	1.5	incendiary
1948	Shelburne River	.5	cigarette
1952	Barn River	1.5	fishermen
	East Allen Lake	3	fishermen
	West River Kedge	6	lightening

Appendix K - Summary of archival data on fires in KNP

This section combines archival material from all sources to describe fires for which information was available. A date and location have been used to identify each fire. Locations are shown on in Figure 7.

Late 1800's - West River

Allen Rowter describes the lower part of West River from the mouth up to, and past, Boyd's Landing (Campsite 22) as being very open when he was first there in the 1930's. Rowter remarked that Boyd's Landing looked "just like a field." Both he and Willis Forrest say there was plenty of evidence of fire continuing farther up the river. He feels the area burned a little earlier than Frozen Ocean (described next). Part of his rationale has to do with the sequence of logging. Much of the early logging was done by companies from Liverpool. The logs were cut in areas accessible by water and driven to Liverpool. They began at Liverpool and worked their way farther and farther up the Mersey and its tributaries. West River was reached earlier than Little River and Frozen Ocean and thus logged sooner. Once they finished logging they were no longer interested in the area and often fire followed the cutting.

Around 1944-45 Allen's father walked from Inness Brook to Northwest Branch Little River. The country was very open with few trees.

1885 - Frozen Ocean Lake

Allen Rowter first saw the Frozen Ocean area in 1936, when he was 10 years old. At that time the area north of the lake was still a barren, the result of the fire around 1885, coming back in gray birch and sour (red) oak. Boulders could be seen throughout the area and in places where fire had destroyed the soil layer, old post-glacial stream courses could be followed for miles. Any moose really stood out. Allen says that people seeing the area today with all the white pines would not believe what it was like then.

When Allen, along with his father, brother and crew, logged the area in the 1950's the trees they cut came from wet areas that had escaped the worst of the fire. In dry areas all the timber had been destroyed. The trees they cut were all fire-scarred and in most cases they discarded the first twelve feet or so of the tree. Allen says such logs would not be left in the woods today.

Allen says that it was obvious the fire had burned around Frozen Ocean as far as Inness Brook. Allen suspects that the large, charred stumps in Burnaby Meadow on Stewart Brook came from this fire. Allen used material from charred stumps in the meadow behind their camp on Frozen Ocean for kindling.

The fire missed the big hemlocks at Dennis Boot Lake. North of Frozen Ocean, the fire extended two miles beyond the park boundary. The fire burned around Torment Brook. Allen felt it might have originated from a log drive on this brook.

The fire burned around Frozen Ocean as far as Still Brook. It didn't burn the hemlocks on the point of land north of the outlet of Still Brook but it burned the forest on the gold ridge heading back toward Big Dam. The wetland along Still Brook must have stopped the spread of the fire south. It missed the area around Little Cook Lake where the Hicks Timber Company logged in the 1950's (see Appendix L). The eastern part of the area logged by Hicks was burned by this fire because the only trees worth harvesting there came from the swamps.

Allen felt that this might be the extent of the fire to the east because of the big trees left at Little Cook Lake. However, Allen said there was evidence of a fire of about the same vintage, which burned from east of Little Cook Lake to the Mersey River and then north, forming a big 'V'.

Although Paine's (1908) description could have applied to a good deal of the country he traveled through, it was this second area that Allen referred to, on the road from Milford House to Jakes Landing, that Paine was writing about in the passage quoted earlier.

Millard (KOH 102) stated that the Frozen Ocean fire burned north to Franklin Lake. Franklin Lake is actually more than 10 kilometers west of Frozen Ocean. He said the fire burned along ridges to the Shelburne River and beyond. In the early 1890's his father cut very large pines at Inness Brook which were still standing but had been killed by this fire. There was no damage to the inside wood and they were able to get 3, and sometimes 4, 16 foot logs from each tree. This cut is no doubt the one described by Miledge Rowter in 1975 as occurring at Dennis Boot Lake. His map is included in Appendix L.

1916 - Eel Weir to Christopher Lake

According to Willis Forrest this fire did very little damage. In the 1930's there was a fair bit of logging in the area burned by this fire. Both the Gordon and Starrett Lumber Company and Nova Scotia Woodenware had operations in the area along the river south of the present park boundary. Nova Scotia Woodenware had 17 brows and kept 17 trucks running through the period they were cutting in 1938.

1921 - McClare-Ford Mine

This fire burned very quickly and with a change in the wind actually burned past the mine camp twice. There was no information on the extent of the fire. There was also a lot of cutting in the area to provide fuel for the boiler. Rev. A.G. McClare (KOH 86) recalled a large fire at the McClare-Ford mine in the summer of 1920 (no doubt the 1921 fire reported in *The Gold Hunter*).

Ca. 1920's - Back Lake

When Willis Forrest was logging in the Silver Lake-Back Lake area in 1946-47, many fire-scarred pines were cut. They cut about 1½ miles along the Peskowesk Road (south of the road and not out to the shore of Peskowesk) and around the west end of Back Lake. The origin of these fire scars might be the 1930 fire mapped on Figure 7 but Willis was convinced that the fire dated from the earlier than that.

Ca. 1920's - Snake Lake Bog

This fire, begun from a campfire that was left unattended, burned the point of land east of Cape Split on the southern shore of Kejimikujik Lake. When the point was logged in the 1950's many fire-scarred pines were cut.

Ca. 1926-27 - Peskawa Lake

Willis described a fire in this area that occurred when he was 6 or 7 years old. The fire burned from Granite Falls on the Shelburne River to Peskawa Lake at the mouth of Lucifee Brook and north to Little Red Lake. For the most part it did not come right to the shore of Peskawa. When Willis was logging the area around the portage between Peskawa and Pebbleloggitch in the 1950's the pines he cut were scarred from this fire. The worst part of the fire, when the fire crew arrived, was some distance from Peskawa because they traveled up the Shelburne to get to the fire rather than using Peskawa Lake.

1929 - Channel Lake

This fire received only a few words of coverage in the Gold Hunter but Allen Rowter was able to provide information on a burned area that he felt dated from this time. The area on both sides of Little River from Channel Lake down towards Kejimikujik Lake was heavily burned. You could see for miles with only big hemlocks left standing. The fire burned as far as Atkins Meadow Brook southwest of Little River. The fire was spotty on the other side of Little River because of wetlands. Walter Sheffer's camp on the east side of the river down towards Kejimikujik Lake stood out for years because the trees were small gray birch and sour (red) oak which came in after the fire. In the 1950's, when Walter logged around his camp, he was only able to cut about 2000 feet of pine because the only pines were a few in the swamps that had escaped burning.

1930 - Peskowsk Lake

No information is available on the 1930 fire shown in Figure 7. Allen Rowter recalled standing on the top of a cleared hill in Maitland Bridge, behind where Raleigh Rowter's mill was located and being able to see smoke from a fire he was told was in the 'Peskowsk country'. He was a boy at the time but feels that 1930 is too early a date for that particular fire because in 1930 he was only 4 years old. It must have been a large fire because the smoke made quite an impression on him. A 4 year old with a good memory, two fires, or the wrong date on the map.

1931 - Dennis Boot Lake

No information on this fire (also shown in Figure 7). Allen Rowter felt the likely cause of a fire in that area at that time would have been lightning because there was no logging or other activity in the vicinity at the time.

1946 - Peskowsk Lake

Ralph Johnson (1952) records a fire from this year at 'Pescawess' Lake that burned 110 acres of cut-over land. The fire was caused by lightning. No more information on the location of this fire could be obtained.

1952 - West River

Although Allen Rowter was in the area when this fire occurred, he did not know its location. Ralph Johnson (1952) records that it burned 6 acres and that the area was forested with pine and pulpwood (see Figure 7). Like many other fires, the area burned varied widely depending on the archival source. In the Keji archives, this fire appears much bigger than Johnson (1952) indicates.

1968 - Mountain Lake

Worden (1997) lists a spot fire at Mountain Lake on August 23, 1968 from Natural Resources archival fire suppression records. A national park Forest Fire Report indicates the fire started from a lightning strike on August 21 and burned less than .1 of an acre.

1969 - George Lake

The Forest Fire Report indicates that this fire on the east side of George Lake occurred on August 25, 1969. The cause was lightning and damage was restricted to two trees.

1970 - Fairy Bay

The Forest Fire Report indicates that this fire was the result of a cigarette butt carelessly dropped in an old sawdust pile. The fire did not extend beyond the pile. (see Figure 7)

1973 - Mount Tom Brook

According to the Forest Fire Report this 25 acre fire was located by the fire tower and caused by a fisherman. It was contained by a water bomber until crews could get to it. The area burned was mostly meadow and the report states that few trees were destroyed. The fire occurred on April 17 (see Figure 7).

1973 - Canning field Road

This fire is included in the available Forest Fire Reports. On June 8, after being reported by the fire tower, two small fires were found less than 100 feet apart in old brush piles along this road. The fires were quickly extinguished. It was concluded that they were deliberately set (see Figure 7).

1977 - Outdoor Theatre

A small fire, started from a cigarette, was discovered along the path to the Outdoor Theatre, on May 22. It was quickly extinguished without fire-fighting equipment. A few square meters of leaf litter were burned.

1982 - Still Brook, near Campsite 4

The Forest Fire Report states that this fire, which burned less than ¼ acre, was started by a cigarette. It was discovered, and extinguished, by backcountry travelers on May 22.

1983 - location unknown

This reference from notes made in KNP fire reports has the same date - May 22, and the same cause - cigarette, as the previous fire.

1987 - Big Dam Lake campsite

This reference, also from notes of KNP fire reports, lists the date as September 7 and the size as 10 square meters. No cause is given, nor is there an indication of which campsite on Big Dam Lake.

1991 - Norway Island

Park employees recall several trees were destroyed in this fire which occurred in late July and was caused by lightning.

1997 - Mersey River

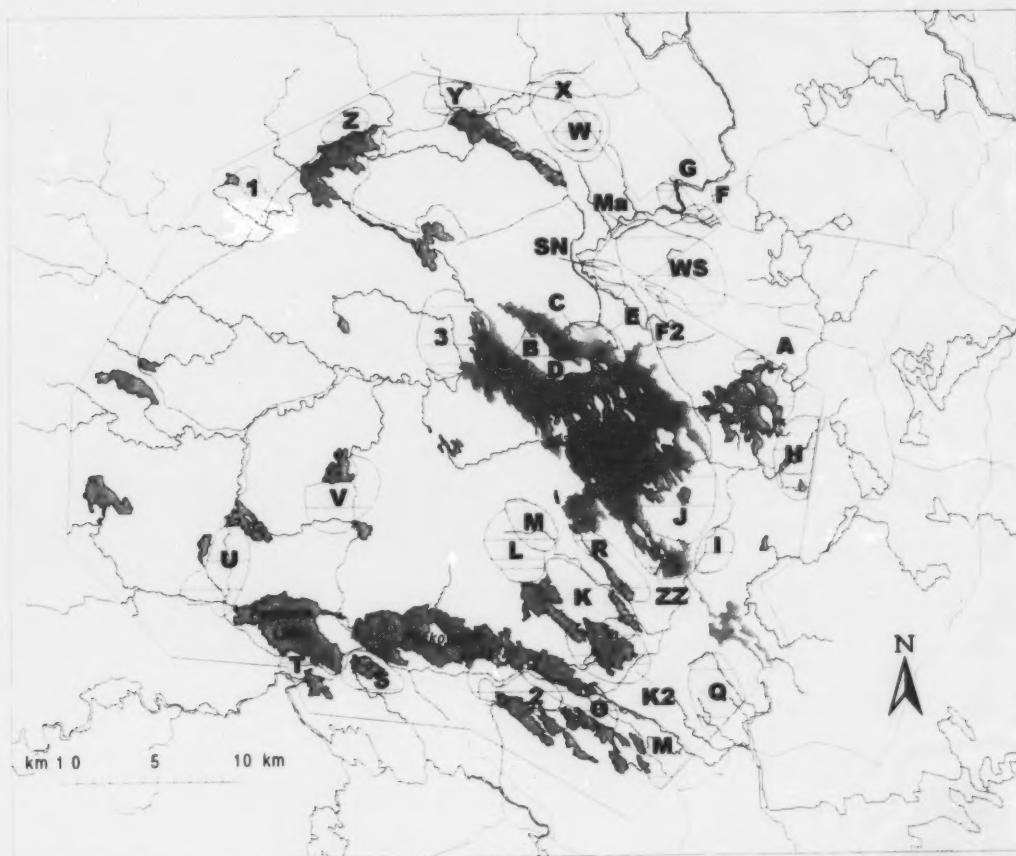
This fire occurred in July with fire risk indices up in extreme. A canoeist on the Mersey River reported smelling smoke. The fire was only discovered after repeated searches of the area. It was smoldering in the ground when discovered. Two trees, some distance apart, were damaged in the incident.

1999 - Luxton Lake; Outflow of Little Peskowsk Lake

At the end of June, Keji experienced a shower of lightening accompanied by only a few millimeters of rain. Smoke patrols revealed a number of strikes throughout the park but only two resulted in fire. Both blazes were quickly extinguished by the park's initial attack crews. Neither grew to more than 0.1 hectares in area.

These are all the fires in Kejimikujik National Park for which oral or written documentation was available. No information was obtainable on a number of the fires detected in field surveys. These include: 1930 - Peskowsk Lake, 1931 - Dennis Boot Lake, 1967 - Mountain Lake (although perhaps this is the 1968 fire given the wrong date), two fires from 1968 on Peskowsk Road and 1969 in Jeremys Bay Campground.

Appendix L – Known logging events in Kejimikujik's history



Areas of historical logging activity in and around Kejimikujik National Park. Data was derived from oral history and archival surveys conducted by Swain (1998). See the table below for additional historical information pertaining to each area.

Appendix L – Known logging events in Kejimikujik's history

The following table annotates the logging history map found above.

Location	Date	Logger	Timber taken	Comments
Grafton lake	ca. 1920	Gordon and Starret Lumber Co. (Liverpool)	pine and hemlock	
A	1943-44	Charles Mason	pine	
B (Indian Point)	1918-19	Gordon and Starret Lumber Co. (Liverpool)	hemlock and hardwood.	
C (Slapfoot campground)	1920	Willard Freeman (Maitland Bridge)	mature stand of hemlock	
D	1938-39	John Rowter	pine, hemlock, oak and poplar	
E (Campground again)	1940	John Rowter (Maitland Bridge)	pine, hardwood, and poplar taken	
F1	1940	Clarence Mason	pine and spruce	East of present entrance gate strip along drumlin
F2	1944	?	hardwoods	
G	1940	William Rowter (Maitland Bridge)	hemlock, pine, oak in the beech grove trail area	mill site above present park administration building
H (McGinty Lake area)	1952	Willis Forrest	pine, hemlock, spruce, and firewood	
I	1952	Lou Naugler	mostly pine	junction of roads to snake lake and eel weir
J (George's Lake)	1950s	Raworth and Mullins Co. (New Brunswick) - cutting by W. Forrest	pine, spruce, hemlock	
K (Puzzle Lake)	1954	Raworth and Mullins Co. (New Brunswick)	pine, spruce, hemlock	
K2	?	?	hardwood	
L	1938, 1939, 1940	Mersey Paper Co.	mature hemlock and spruce stands	East of fire tower
M	1957	Joseph Shupe (Kempt)	hardwood	
N	1929-1930	Mersey Paper Co.	mature stands of hemlock and spruce	Peskowesk, Little Peskowesk, and Hilchemakaar Lakes
O	1950	Charles Mason	pine	
P (Mountain Lake)		Raworth and Mullins (by Joseph Shupe (Kempt))	white pine	mill site
Q (Square Camp Brook)	1944-45	Raworth and Mullins	white pine	

Appendix L – Known logging events in Kejimikujik's history

(Continuation) The following table annotates the logging history map found above.

Location	Date	Logger	Timber taken	Comments
R (Beaver Lake)	1949-50	Charles Mason	mostly white pine, some hemlock behind Minards Bay	about 1953-54 Mason opened road from Peskowsk to fire tower road
S (Beaver Lake area)	1955	Clarence Mason	white pine	
T (Pebbleloggitch area)	1953-54	Clarence Mason	white pine	
U (Luciffee Brook and Red Lake area)	1953	Lou Naugler	white pine	
V (Luxton Lake)	1954	Clarence Mason	white pine	
W (Big Dam Lake)	1945-46	Clarence Mason	white and red pine	East of Big Dam Lake
X	1950	Joseph Rogers	spruce and white pine	
Y	1956	Hicks Timber Company (Bridgetown)	white pine, spruce	North of Big Dam Lake
Z	1954	Frank Rowter	white pine, spruce	North of Frozen Ocean Lake
1 (Dennis Boot Lake)	late 1800s	Millard Timber Co. of Milton, Queens County	pine, hemlock	probably around 1890
2	1946&47	W. Forrest	?	below Peskowsk Lake
3	1947&54	J. Rowter	?	Atkins Brook
Ma	1946	Clarence Mason	pulp, pine, hardwood	Northwestern side of drumlin to below J.R. Bridge
WS	until 1964	Walter Sheffer	pulp and pine	pit props exported to England
SN	1956-59	Tim Rowter	??	
ZZ	?	?	?	

Note: Additional information on the park's logging history was collected after this study's completion. Aerial photographs from both the 1920's, 1940's and 1950's, purchased by the park, contain new harvesting data on areas previously thought unlogged. These photographs are held at the park's interpretive centre.

Appendix M - Summary of all known fire events in KNP

A summary of all known fires in the KNP region is given. Data were drawn from both field and archival sources. Included is the date, location, source of ignition, size, and intensity of each blaze, as was available. See Appendix A for list of acronyms used to describe tree species.

Understory fires Derived from field data collected in 1997. The size and source of ignition for these fires was not available. Dates were cross referenced among samples found within close proximity; fires within three years were combined as one fire event.

Sample Site	Date						
bS5	1950	1977					
Burn1	1870	1926	1943	1978	1990		
Burn3	1925	1938	1944	1950	1968	1972	1989
He1	1872	1954	1972	1978	1983	1992	
He2	1889	1903	1920	1928	1944	1951	1963
He3	1941	1942	1948	1957			
He4	1956	1981					
He5	1839	1934	1946				
rO3	1939	1944	1949	1954	1957	1962	1978
rO4	1925	1946					
rM2	1902	1939	1958	1971	1985		
rM3	1925	1936	1955				
rM4	1803	1866	1919	1930	1956	1985	1990
rP1	1913	1939	1977				
rP4	1877	1884	1895				
rP5	1901	1918	1931	1937			
wB1	1885	1889	1939	1952	1957	1981	1985
wB2	1912	1956	1962	1966	1982		
wP1	1950	1952	1964	1968	1988		
wP3	1911	1933					
wP4	1872	1898	1919	1928			
wP5	1899	1927	1948	1976	1983		

Outline of all other fires identified. Data synthesized from field and archival sources with emphasis on overstory fires. Area given in hectares. Field data – FD; Local resident – LR; Park records – PR; Local newspaper – LN, Provincial records – PVR, Johnson (1952) – JN, Park Staff – PS

Location	Date	Intensity	Area	Data source(s)	Comments
wP4	1849	high	27.4	FD	Likely stand replacing
wB1	1885	high	2.2	FD	Likely stand replacing
West River	late 1800s	mixed	??	LR	?
Frozen Ocean	1885	high	??	PR, FD, LR	Several fires, likely stand replacing
rS5	1909	high	3.5	FD	Likely stand replacing
rP4	1910	high	4.7	FD	Likely stand replacing
wP3	1910	high	50	FD	Likely stand replacing
wB3	1912	high	10.9	FD	Likely stand replacing
rP2	1915	high	7.3	FD	Likely stand replacing
Eel weir	1916	low	??	LR	
rP5	1917	high	1.2	FD	Likely stand replacing
McClare-Ford mine	1921	?	?	LR	Burned twice (in same year??)
Back Lake	ca. 1920s	low	?	LR	
Snake Lake bog	ca. 1920s	low	?	??	Likely started by campfire
bS3	1923	high	9.1	FD	Likely stand replacing
bS1	1925	high	7.5	FD	Likely stand replacing
Peskawa Lake	1926-1927	high	??	LR	Likely stand replacing
Channel Lake	1929	??	??	LR, LN	
wB2	1928	high	13.4	FD	Likely stand replacing
Pebbleogitch Lake	1930	high	??	PR	Wrong date?? Anthropogenic ignition
Dennis Boot Lake	1931	high	81+	PR, field data	Lightening ignition; confirmed (field data)
rP1	1932	high	7.1	FD	Likely stand replacing
rS3	1933	high	1.2	FD	Likely stand replacing
rP3	1934	high	1.2	FD	Likely stand replacing
rO2	1943	high	14.5	FD	Likely stand replacing
Peskowesk Lake	1946	??	44.5	JN	Lightening ignition; confirmed (field data)
wP1	1949	high	1.4	FD	Likely stand replacing
rO4	1951	high	26.2	FD	Likely stand replacing
West River	1952	??	2.4	PR, JN	Lightening ignition; confirmed (field data)
Mountain Lake	1968	??	0.04	PVR, PR	Lightening ignition
George Lake	1969	??	??	PR, FD	Lightening ignition; confirmed (field data)
Fairy Bay	1970	??	??	PR	Caused by cigarette
Mount Tom Brook	1973	??	10.1	PR	Started by fisherman
Canning Field Road	1973	??	??	PR	deliberately set
Outdoor theatre	1977	??	??	PR	Caused by cigarette
Still Brook	1982	??	0.1	PR	Caused by cigarette
Big Dam Lake	1987	??	0.01	PS	No formal report written up
Norway Island	1991	medium	0.2	PS	Lightening ignition; confirmed (field data)
Mersey River	1997	low	spot	PS	Lightening ignition; confirmed (field data)
Luxton Lake	1999	low	spot	PS	Lightening ignition; confirmed (field data)
Mud Lake	1999	low	spot	PS	Lightening ignition; confirmed (field data)

Appendix N – The species *response-to-fire* approach adapted from Rowe (1983)

A matrix was developed to illustrate how some Acadian forest species utilize different reproductive strategies to help them deal with fire (see table below). The approach was adapted from Rowe (1983). Rowe (1983) drew heavily upon Noble and Slater (1977) and a host of other researchers to both devise and support his methodology. The reader should consult Rowe (1983) for further information regarding the rationale supporting the approach.

Species-level response matrix outlining select Acadian tree species' adaptive relationship with fire

Short, intermediate fire rotation	Intermediate fire rotation	Intermediate, long fire rotation	Long fire rotation
Invaders; VI (VT) <i>Betula papyrifera</i>	Evaders; CI <i>Picea mariana</i>	Evader; DT <i>Tsuga canadensis</i>	Avoiders; DT <i>Picea rubens</i> <i>Abies balsamea</i> <i>Picea glauca</i>
Endurerers/Resistor; VDT <i>Quercus rubra</i>	Endurerers; VD (VT) <i>Acer rubrum</i>	Resistor; DI <i>Pinus strobus</i>	
	Resistor; DI <i>Pinus resinosa</i>		

Outlined below is a description of the criteria used to classify each species as paraphrased from Rowe (1983).

Regeneration niche of plant species

1) **MODE OF REGENERATION AND REPRODUCTION – FIRST VITAL PROCESS**

Vegetative-based:

V species – able to resprout if burned in the juvenile stage

W species – able to resist fire in the adult stage and to continue extension growth after it (though fire kills juveniles)

Disseminule-based:

D species – with highly dispersed propagules

S species – storing long-lived propagules in the soil

C species – storing propagules in the canopy

2) **COMMUNAL RELATIONSHIPS – SECOND VITAL PROCESS**

T species – tolerants that can establish immediately after a fire and can persist indefinitely thereafter without further perturbations

R species – tolerants that cannot establish immediately after fire but must wait until some requirement has been met (e.g. shade)

I species – intolerants that can only establish immediately after a fire. Rapid-growth pioneers, they tend to die out without recurrent disturbances.

Mode of persistence – functional adaptations of plants

Invaders – shade intolerant; early successional; produce abundance of wind disseminated propagules

Evaders – Disseminule based; store seeds in canopy, humus, or mineral soil. Evade high temperatures then rapidly reproduce. Dormancy for seeds stored in soil or humus.

Avoiders – Least adapted to fire; arrive late in successional progression; prosper where fire cycles are long.

Resistors – Employ above-ground flame resistant techniques, e.g. shortage of ladder fuels, thick bark, reduced foliage flammability

Endurers – Plants that can resprout after fire

Appendix O - Outline of sampled fire-scarred trees

Included in the outline is a description of each sampling site. Indicated are each scarred tree's species (sp.), breast height diameter (dbh), the height of the largest scar, the number of visible scars, site slope, aspect, the aspect of the largest scar, tree mortality, and the height at which the cross section (X.S.) was sampled. (m - meters, cm - centimeters, ID - identification). See Appendix A for outline of tree acronyms.

Tree	Plot ID	Sp.	DBH (cm)	Scar Height (m)	# scars	Slope (°)	Aspect (°)	Scar Aspect (°)	Crown Mortality(%)	X.S. (cm)
1.	RP0	wP	34	0.390	1	12	074	163	na	na
2.	RP0	rP	23	1.01	1	8	242	241	na	na
3.	WP0	rO	27	0.710	1	2	026	197	na	na
4.	WP0	WB	38	0.790	1	2	026	216	na	na
5.	HEM0	He	44	0.280	1	9	030	164	na	na
6.	HEM0	He	33	0.490	2	9	030	105	na	na
7.	BRN2	wP	44	1.45	1	1	120	315	na	na
8.	BRN2	rO	60	1.54	2	1	120	144	na	na
9.	RP5	rP	54	3.47	2	1	359	194	na	na
10.	RP5	rP	32	0.320	1	1	359	108	na	na
11.	BRN3	rO	60	2.69	1	6	215	148	25	5
12.	BRN3	wP	62	0.530	1	4	038	094	<5	5
13.	RM6	rP	44	0.260	1	0	--	002	<5	5
14.	RM6	wP	45	2.43	1	0	--	192	<5	5
15.	MS5	wP	39	1.04	2	6	317	203	<5	45
16.	O4	rO	36	0.807	3	6	069	186	<5	5
17.	O4	IrA	59	0.703	1	6	069	326	<5	5
18.	HEM5	He	41	1.8	2	3	148	353	<5	5
19.	HEM5	wP	40	0.620	1	10	187	099	10	35
20.	WB4	wB	26	1.34	1	4	034	329	<5	30
21.	WP1	wP	69	0.410	1	8	034	034	<5	15
22.	WB2	Be	40	0.701	1	5	171	076	15	5
23.	WB2	He	39	2.05	2	10	020	149	<5	5
24.	WB1	wB	30	0.440	1	6	169	169	<5	5
25.	WB1	wB	28	0.590	1	14	077	077	<5	5
26.	HEM4	He	23	0.620	1	8	059	235	<5	30
27.	BRN1	rP	44	1.47	1	2	125	284	<5	105
28.	HEM1	rS	33	0.480	1	4	137	033	<5	10
29.	HEM1	He	49	1.05	1	3	232	023	<5	45
30.	WP2	wP	46	1.22	1	5	081	155	<5	25
31.	WP6	wP	42	1.11	2	8	053	237	<5	10

Appendix O - Outline of sampled fire-scarred trees (continued)

Tree	Plot ID	Sp.	DBH (cm)	Scar Height (m)	# scars	Slope (°)	Aspect (°)	Scar Aspect (°)	Crown Mortality(%)	X.S. (cm)
32.	WP6	wP	53	0.320	1	5	033	001	<5	10
33.	WP4	wP	62	3.18	1	7	039	039	<5	15
34.	WP4	wP	70	3.87	1	7	039	016	<5	20
35.	HEM6	He	68	0.950	3	10	112	325	<10	10
36.	HEM6	He	43	0.660	1	8	112	305	<5	5
37.	RP3	rP	44	0.580	1	4	221	059	<5	20
38.	RP3	rP	60	0.500	1	8	222	026	<5	10
39.	RM3	wP	56	2.50	1	5	109	248	<5	10
40.	RM2	La	36	1.30	3	0	--	136	<5	30
41.	RM2	rM	56	0.940	2	0	--	109	15	15
42.	BS8	wP	40	1.17	1	0	--	052	10	5
43.	O5	wB	31	0.680	1	12	237	091	<5	5
44.	O5	rO	35	0.810	1	12	237	059	<5	10
45.	S4	La	36	0.40	1	0	--	265	20	10

Appendix P – Interspecific variations in scar physiognomy and cross-section sampling procedures

Populus grandidentata

Scar physiognomy

The majority of fire scarred *P. grandidentata* are medium to large sized stems with breast-height diameters of at least 45 centimeters. Typically, fire wounds are evenly symmetrical and tear-dropped shaped. As the species is very prone to decay (Alden 1995), older scarred trees are often hollow with open scar cavities. These trees usually have a multiple fire history and are blackened on the inside, charcoal running deeply into the heart of each tree.

Sampling

P. grandidentata is the least dense hardwood sampled with a green-wood specific gravity of 0.36 (Alden 1995). Despite this, the species can be cross sectioned quite thinly, without risk of checking; samples less than four centimeters in thickness are not however recommended.

Hollow centered samples should be extracted both through and above the scar cavity to maximize the accuracy and precision of scar records.

Preserving

Large toothed aspen exhibit low to moderate levels of shrinkage with air drying. As such, the risk of radial cracking is relatively low. Tangential shrinkage is 2.6% (in air dried samples with 20% residual moisture) on average (Alden 1995), the lowest of any Acadian hardwood species except *Fraxinus americana*.

Aspen will easily sand to a smooth characteristically fuzzy surface. Although this species does not assimilate preservatives readily, two weeks of air drying is sufficient to allow for sanding and varnishing of cut surfaces. Finished surfaces are not typically tacky.

Interpretation

Large tooth aspen wood is yellow-white and uniformly textured. Growth lines are faint but clear enough to allow for interpretation. Cross-sections taken near the apex of a scar do not typically provide clear growth records but can be cross referenced with samples taken above and below.

Scarred areas are sometimes blackened although it is not apparent whether the colouration is associated with a resin excreted during the healing process.

Fagus grandifolia

Scar physiognomy

The beech tree has very likely the thinnest bark of any medium to large sized tree in the Acadian forest. Consequently it is not particularly flame resistant. The tree figured below exemplifies this intolerance. This medium sized beech revealed a tree ring pattern so contorted it was difficult to locate the tree's pith.

Beech fire scars are not easy to recognize because of their rarity and on account of the disfiguring bark disease so prevalent among trees of this species. *Nectria coccinea* a disease spread by the insect *Cryptococcus fagisuga* causes cankerous growths on beech bark (Farrar 1995), obscuring fire scars and causing many blemishes and scars on its own. However, all beech fire wounds are consistent in that they fail to heal considerably; scars are open and deep.

Sampling

Fagus grandifolia is a very dense hardwood with a green-wood specific gravity of 0.56 (Alden 1995). The species is not resistant to heartwood decay however and often looses its centre in larger scarred trees. In medium sized samples, beech behaves very similarly to white birch. It's pith remains intact though spongy and difficult to interpret. Care must be taken during sectioning although samples can be sliced relatively thin.

Preserving

Beech exhibits moderate levels of tangential shrinkage at 3.7% in air dried samples with 20% residual moisture (Alden 1995). Samples rarely crumble or crack significantly. Cracked samples do not glue well.

F. grandifolia is moderately permeable to varnish. The wood dries quickly though and can be sanded and finished after ten to fourteen days. Beech wood takes a good polish offering a clear plane for annular ring interpretation.

Interpretation

As mentioned above, beech bark is very flame intolerant. The cross section sample pictured below illustrates this clearly. Repeated ground fires over the tree's approximate 100-125 year life span initiated a 'growth twisting' whereby the stem actually curled over on itself, around each injury, at least three times. At the time the tree was cut, its centre was distal to the stem's geometric median, to the point where it was on the trunk's periphery, the pith rotten and exposed to the outside. Amazingly enough, the tree showed low to medium-low canopy mortality. Dendrochronology in samples like this and in similarly contorted beech cookies is difficult at best. Time since fire dates can still be obtained relatively accurately though provided some sectors of the disk are intact.

Betula spp.

Scar physiognomy

White birch fire scars are easier to typify than yellow. If a scar is not severe enough to kill a white birch tree it will usually leave a distinctive scar. Fire scars are ovoid in shape and bare down to the wound. That is, they never heal over, even in part. Charcoal-coloured creases, running from the ground up, are very common but are not usually associated with fire. The birches are also very resinous although the dark resin's presence is restricted to the outside of the bole face.

Yellow birch fire scars do not conform to a characteristic archetype. The species has thicker bark than *B. papyrifera* (especially in older trees) but does not form cat-faces like

the softwoods or bark seams like *Quercus rubra*. In larger trees, scars are gnarled and amorphous although some loosely resemble the characteristic tear drop shape. In smaller trees, the species scars like white birch but few were found to confirm this pattern. Despite its thickness, the oil in *Betula alleghaniensis*' bark predisposes it to flame damage.

Sampling

Birch, like all the hardwoods, can usually be cut as thin as four to five centimeters without risk of crumbling. White birch is one of the least dense sampled, second only to aspen, with a green wood specific gravity of 0.48. Yellow birch is denser at 0.55 and poses fewer problems during cross sectioning.

The difficulties in sampling white birch involve its heartwood. This species is often rotten in the centre but rarely forms a hollow cavity. As such, the decadent tissue can be preserved during cookie extraction if care is taken to avoid jostling it with the tip of the chainsaw bar. This practice will help ensure the cookies stay together but does not usually provide additional fire data.

Preserving

Birch exhibits moderate to high levels of tangential shrinkage. Shrinkage is 2.9% (in air dried samples with 20% residual moisture) on average in white birch and 3.1% in yellow (Alden 1995). Levels in these two species are the highest of all Acadian hardwoods. Despite this, five centimeter (or greater) thick cross-sections will seldom crumble or crack markedly.

Both birch species are easily finished (Alden 1995). The wood dries very quickly and can be varnished a week to ten days after cutting.

Interpretation

Birch dendrochronology is more challenging than analyses conducted for any of the other hardwoods. *B. alleghaniensis* and *B. papyrifera* are both fine and uniformly textured

(Alden 1995) with very faint grains.

White birch rings in particular are difficult to decipher. The species is difficult enough to interpret in the absence of scarring but becomes near impossible after repeated injury. That is, ring patterns in scar tissue are usually completely obscured. The scar tissue itself is often intact but resembles a chalky pulp. The easiest fires to date are the smaller spot fires, having imposed little damage, and the larger scars produced from single fire events.

Tissue stains such as gentian violet and or methylene blue (better) will sometimes improve tree ring resolution. Glycerin should not be used to improve clarity as it does the opposite. In increment bore samples, a scalpel should be used to cut a viewing plane across the grain before stain is applied.

Acer spp.

Scar physiognomy

Red maple is scarred more often than not especially in larger trees. The trouble is the majority of these scars are not affiliated with fire; those that are very difficult to recognize without cutting the tree down. The species does not have an stereotypic fire scar profile nor is charcoal easily located with increment bore sampling.

Sugar maple is rarely fire scarred. The species is rarely scarred markedly at all in fact. Existing scars usually close over as bark seams.

Sampling

Sugar maple cookies can be cut as thin as four centimeters. The wood is evenly matched with beech and oak in density (0.56 green-wood specific gravity (Alden 1995)) and can be sectioned quickly and precisely. In the long term, high levels of tangential shrinkage (Alden 1995) predispose sugar maple to severe cracking. Samples intended for long term preservation should be cut six to eight centimeters thick and carefully seasoned.

Red maple wood is moderately hard but not strong (Alden 1995). This coupled with the repeated frequency of heart rot in this species make it a difficult wood to cross-section, particularly in larger (breast height diameters greater than 45 centimeters) samples. As such, many cookies will fall apart, even before drying commences.

Preserving

Acer saccharum dries quickly and can be varnished after a week or two but won't retain the varnish well without further drying. With careful seasoning sugar maple will polish extremely well; the wood is hard and strong with a smooth even grain.

Red maple dries quickly and will hold varnish after 10 days. In scarred samples, the wood does not finish well nor do cross sections remain intact for long periods.

Interpretation

More so than any other species, red maples are usually missing their centers, regardless of scar presence. This makes it almost impossible to age these trees or do date fire years early in their history, especially when cores are used. In some cases, scar-wood may be intact but like birch and most other hardwoods, this tissue's growth patterns are wildly variable, its annual rings irregular. Black spider-web like colour patterns are also common, serving to further obscure fire evidence. Fire scars do exist though, the more recent they are, the easier they are to date.

Sugar maple's very white wood has faint but visible annual rings. Core samples are very difficult to interpret, cross sections marginally better. Methylene blue works quite well as a stain but should be applied in dilute layers (0.1% solution); too much stain will conceal growth records.

Larix laricina

Scar physiognomy

Larch scars easily and exhibits a extensive variety of scar shapes and sizes.

Unfortunately, for fire researchers, the majority of these scars often originate from other

environmental variables. Increment bore samples do not offer much aid in fire scar authentication as scarred samples are usually rotten and honeycombed with dark resin. This makes it very difficult to locate scar tips and to verify the presence of charcoal. Decent samples usually come from smaller trees with a scant fire history.

Sampling

The species is, by far, the heaviest and hardest softwood of any in Canada (Farrar 1995). With the smaller diameters of most scarred samples, however, this attribute will not impede cross-section transport from the field.

Many scarred larch are relatively rotten from the bole periphery to the pith. In contrast, unscarred samples are considered moderately resistant to decay (Johnston 1990). Cross sections should be sliced at least five centimeters in thickness to maintain their intactness.

Preserving

Tangential shrinkage is low at 2.5% (Alden 1997) but the small size of most samples will lessen the effect this might have had on cross-section integrity.

This species is the slowest to dry of any tree in Nova Scotia. Wood can be sanded a couple weeks after cookie extraction but it's sticky sap usually intermixes with sawdust leaving a grainy film that is difficult to remove (from green samples) and masks growth rings. Larch should be dried for several weeks before it will hold varnish in any capacity. The species is known for its oily wood and poor potential for chemical preservation (Alden 1997).

Interpretation

In samples with multiple fire histories, growth rings are often significantly obscured. Scar tissue remains intact but is usually discoloured and uneven. Faint growth rings can be enhanced with some success before varnish is applied using a 0.01% solution of methylene blue or gentian violet.

Quercus rubra

Scar physiognomy

In oak trees, with breast-height-diameters (dbh) over 45 centimeters, heart rot is prevalent, regardless of scar presence. Larger scarred oaks are often open at the bottom, a hole formed where once there was injured wood, the live scar tissue delineating the cavity's shape and revealing the tree's hollow centre. It is not uncommon to evidence animal use of these enclosed spaces. It is also worth peering into each hollow cavity because their walls are almost always lined in charcoal. These tear dropped shaped scars are characteristically low and wide.

Small to medium (less than 45 centimeters dbh) oaks exhibit stereotypic bark seams, sometimes stemming from a fire early in a tree's history, the margins of scar tissue pressed tightly together and forming a thin narrow fissure running from inside out. Oaks do not seem to be adversely affected by flame heat; the tree gets injured, the injury heals well, and the tree keeps on growing seemingly much like it would have without the wound.

Sampling

Oak trees cross-section very easily. This relatively dense hardwood can be sliced as thin as four centimeters without great risk of crumbling. This is particularly true of samples with intact piths, regardless of bole diameter. Large hollowed trees, with breast-height-diameters over 45 centimeters, are better left standing. These stems can be increment-bored for time-since-fire data. Cross-section samples from such boles are difficult to cross-section easily, cumbersome to transport, and difficult to interpret.

Preserving

Tangential shrinkage in *Q. rubra* is low to very low at 2.7% in air dried samples with 20% residual moisture (Alden 1995). The wood will crack but it is rare a good cross-section will fragment significantly. Cracked samples hold glue very well.

Oak wood finishes excellently. The wood sands to a hard smooth surface and assimilates preservatives readily. Varnish will hold after one and a half to two weeks of drying. With this duration, varnish will not bubble but the wood remains cold to the touch, moisture still trapped inside; despite this, tree ring analyses can be conducted effectively.

Interpretation

Relative to other hardwoods, oak trees offer the clearest tree ring history. This wood's vascular tissue is coarse, often readily interpreted with the naked eye. Annual rings are also frequently intact and distinct in scarred areas. Trees with bark seams (showing charcoal in increment bore samples) provide the best information, usually offering a clear record from the tree's origin to present day.

Tsuga canadensis

Scar physiognomy

Fire scars are found on medium to large (greater than 35 centimeters dbh) stems and most often in the purest and oldest of stands. Scars tend to be short and moderately shallow with charcoal featuring prominently in their colouration, regardless of scar age. No evidence exists to indicate whether the height of hemlock scars is more a measure of the intensity of fires they typically endured or a function of their physiological response to those fires. Scars are usually tear dropped shaped but are less often as symmetrical as the 'cat-faces' found in the pines. Unlike other softwoods, most hemlock fire scars do not run completely down to or below the ground layer. Smaller scars often heal over completely, but are not visible as bark seams or grooves from the outside.

Sampling

Hemlock is one of the better woods for taking increment bore samples, regardless of the presence of scar tissue. Cross-sections surprisingly do not hold together as well, particularly in larger trees (greater than 50 centimeters dbh). In fact large hemlocks are probably the worst species to sample for cross-sections, the moist wood inside fragmenting and offering little for interpretation. A possible solution would be to interpret scarring in the field, directly from the butt of the felled tree. In the winter, water

could be poured over the cut surface and later a razor blade used to slice clean a plane for viewing.

Preserving

Tangential shrinkage in *T. canadensis* is low to very low at 2.3% (in air dried samples with 20% residual moisture)(Alden 1997), second, among the softwoods, after white pine. Cross-sections rarely crack markedly.

Hemlock dries quickly and will hold varnish after a week. It's heartwood is only slightly resistant to decay (Alden 1997) but with the size of tree usually selected for sampling, this is not a problem.

Interpretation

Hemlock cross sections tend to be riddled with resinous lines; these lines often follow growth rings and spider-web out from scar tissue. This resin seems to be associated with the tree's healing process and is even sometimes found on the bole and or scar face. The resin is black and shiny like charcoal but when teased out with scalpel or sharp probe looses it's charcoal-like characteristics, resembling a dark-red granular pulp. To confuse things even more though, charcoal is sometimes embedded in the resin itself. A probe and dissecting microscope will confirm its presence. Rings around scars are usually clear enough to count and scarred areas in small to medium sized trees are ordinarily quite intact.

Pinus resinosa

Scar physiognomy

Fire scars are prevalent in red pine but the majority do not often show up as cat faces or bark seams. Most red pine fire scars are healed over and not easily detected from the bole face. A careful bole examination may however reveal some artifacts of scarring. Healed over scars sometimes show up as long narrow depressions. These grooves widen slightly at the tree base like a bark seam but unlike any other species are smooth bottomed and shallow, this tree's characteristically scaly bark layered over the injury. As

similar grooves appear over old lateral branches and adjacent to root buttresses, core samples should always be used to confirm the presence of charcoal. Note the difficulty, which sometimes arises, in using an increment bore to locate the scar tip, and the charcoal usually found with it, because of the tree's ability to close so tightly around each injury.

Cat faces do occur as the result of repeated injury and are sometimes quite large. Unlike white pine, however, these scars are often irregularly shaped, the lips on either side asymmetrical to one another.

Sampling

In larger trees (greater than 45 centimeters dbh), or those with severe injury, rotting occurs in association with scar tissue, thus making it difficult obtain intact cookies. These rotten areas are however relatively easy to interpret in the field from the stump or from a longer section of trunk. Thicker cookies are impractical to transport as red pine wood is relatively dense (Alden 1997) and often damp in scarred samples. Red pine should be cross-sectioned at least seven centimeters thick.

Preserving

Tangential shrinkage in *P. resinosa* is intermediate to low at 2.4% (in air dried samples with 20% residual moisture)(Alden 1997). Most larger scarred samples are hollowed centered nonetheless and will fragment regardless of shrinkage.

Red pine does not dry quickly; it will hold varnish after a week and a half and leach moisture for several more. After drying is complete it finishes well and yields well to preservatives (Alden 1997).

Interpretation

Red pine cross sections and core samples are in general very easy to age, perhaps the easiest of all regional conifers next to *Picea rubens*. Red pine resin is not usually confused with charcoal but old lateral branches sometimes resemble healed over scars.

Pinus strobus

Scar physiognomy

This species offers a diversity of external scarring patterns, including the cat face and bark seam. In older stems, its thick bark is a considerable flame barrier (Wendel and Smith 1990). Consequently, white pines often withstand relatively hot surface fires, many producing dramatic scars, upwards of 4 meters in height. These should not be confused with lightening strikes which run top to bottom not from the ground up. White pine is also predisposed to many other types of scarring. It is one of the best trees on which to see bear scratchings and the impact of wood dwelling beetles.

Sampling

Cross sections should be sliced at least seven to eight centimeters in thickness. Even larger trees are good candidates for sampling as the species exhibits excellent levels of heartwood decay resistance.

Preserving

White pine shows the lowest level of tangential shrinkage of any Acadian softwood species (Alden 1997). Despite this, multiple scarred samples from larger trees (greater than 45 centimeters dbh) usually crack, in many cases bisecting the scar tips. Crumbling is not a problem in this species though. Most trees show good post-fire resistance to rot; the species has one of the highest levels of heartwood decay resistance of any in the region (Alden 1997).

White pine does not dry quickly; it will hold varnish after two weeks; moisture usually leaches out for quite a while after, leaving the surface tacky. White pine finishes and glues well; it will assimilate preservatives relatively easily (Alden 1997).

Interpretation

In samples with multiple fire histories, growth rings are often significantly obscured. Scar tissue remains intact but is usually discoloured and uneven. Faint growth rings can

be enhanced with some success before varnish is applied using a 0.01% solution of methylene blue or gentian violet.

It is rare to find charcoal on the scar face but it is quite easily distinguished against the white wood in increment bore samples. In using increment bores, white pines are one of the better trees to find scar tips. After scarring, sap wood curls around both sides of the wound in a very predictable pattern, much like the two contiguous arcs atop a heart shape. Resin ducts are common in white pine, sometimes resembling spot fires, and even found in association with growth irregularities about the bole face.

Picea spp.

Scar physiognomy

It is difficult to find good *Picea* scars of any species. Most are found on red spruce, their patterning tending toward the classic cat-face. These scars are shallow and short. Larger scars are uncommon, quite likely because of the species intolerance of hotter blazes. Charcoal may be found on the bole face but it is usually cryptically hidden by the species' crusticose bark.

Black spruce boles are often marked with narrow irregular striations but no evidence exists to correlate their presence with fire.

Sampling

Red spruce is easy to cross-section. Most scarred sample have been impacted negligibly enough to warrant high cross-sectioning success rates. The wood cuts easy and is rarely rotten enough to compromise cookie structure. Red spruce is also light and easy to transport from the field. Samples can be sectioned as thinly as five centimeters.

Preserving

Tangential shrinkage is relatively high at 2.6% (Alden 1997) but the smaller size of most of the red spruce still available for sampling will lessen the effect this might have had on cross-section durability.

Red spruce dries very quickly. Surfaces dry faster than those of all other Acadian species and can be sanded and finished after a week to ten days.

Interpretation

Red spruce cross-sections are the easiest of all softwoods to date. Scar tissue is somewhat prone to decay but growth rings are usually still visible.

Appendix Q - Sample site locations and attributes. (m - meters, L - lake, R - river).

Sample site locations and attributes. (m - meters, L - lake, R - river, easting and northing given in NAD 27).

Plot ID	Stand Type	Aerial Photo	Easting	Northing	Elevation	Comments
bS1	Black Spruce	92333-9	324262	4917138	130	Opposite Merrymakedge
bS2	Black Spruce	92326-60	321228	4921409	100	Across from road to
bS3	Black Spruce	92337-52	319243	4920275	90	Off Heber Brook
bS4	Black Spruce	88313-203	310222	4908872	100	Below Peskawa L., near
bS5	Black Spruce	92326-49	311602	4922522	100	1.5 kms up Innes Brook
He1	Hemlock	92340-96	314591	4908459	140	Between Beaverskin &
He2	Hemlock	92336-22	319574	4924868	100	Hemlock & hardwoods trail
He3	Hemlock	92339-94	323439	4911903	110	Hemlock Island, Southern
He4	Hemlock	92337-165	323615	4918343	105	Canning Field road
He5	Hemlock	92336-127	309454	4924097	130	Dennis Boot Lake
MS1	Mixed Softwood	92336-141	320888	4922956	110	Near Big Dam parking lot
MS2	Mixed Softwood	92336-138	318529	4922976	115	Above trail to Channel Lake
MS3	Mixed Softwood	92326-59	320614	4921314	95	Start of road to Big Dam
MS4	Mixed Softwood	92337-51	318547	4919920	140	Northern tip, Jeremy's Bay
MS5	Mixed Softwood	92340-94	313386	4909382	105	Poison Ivy Falls
rO1	Oak	92339-92	320351	4912492	150	Fire tower road, near portage
rO2	Oak	92339-92	321943	4912311	95	Between Keji L. & N.
rO3	Oak	92339-209	324461	4910554	105	Portage to Loon Lake
rO4	Oak	92340-109	326677	4908878	100	Southeastern branch of Loon
rO5	Oak	92336-132	313769	4923462	150	Off portage U
rM1	Red Maple	92335-26	319583	4926328	100	Road to Thomas Meadows
rM2	Red Maple	88313-59	2305772	4915925	165	Lewis Meadows
rM3	Red Maple	92337-148	308802	4917981	130	Little Liberty Brook
rM4	Red Maple	92339-83	313528	4912628	90	Near Ben Lake
rM5	Red Maple	92326-54	316026	4922585	115	East Coast, Channel Lake
rP1	Red Pine	92354-65	322541	4903764	100	Southern tip of park
rP2	Red Pine	92336-138	317998	4922605	105	Above trail to Channel Lake
rP3	Red Pine	92337-156	314776	4918118	135	North of West R., West of
rP4	Red Pine	92337-156	316500	4919228	160	Below Atkins Meadow
rP5	Red Pine	92337-154	315095	4918160	95	North of site 22, West R.
rS1	Spruce	92326-60	320843	4921866	105	Road to Mersey, from B.
rS2	Spruce	92338-177	307946	4916554	100	Near site 42, Liberty L.
rS3	Spruce	92326-151	306719	4918083	95	Near Warden cabin, Liberty
rS4	Spruce	92339-81	312291	4912441	120	1-2 km West of Ben L.
rS5	Spruce	92338-187	318679	4915685	90	North of Mount Tom Brook
wB1	White Birch	92338-192	323542	4915526	90	Peale Island, centre atop hill
wB2	White Birch	92337-161	320562	4917919	110	Indian Point, in from picnic
wB3	White Birch	92337-165	323880	4918316	100	Power line road, off Canning
wB4	White Birch	92336-146	324218	4922518	115	Across from kiosk, follow
wB5	White Birch	92336-132	313014	4923859	115	Off Frozen Ocean L.
wP1	White Pine	92341-2	311915	4908516	100	0.5 km past Mason's cabin
wP2	White Pine	92336-141	321976	4922037	120	On J-line, near roadside
wP3	White Pine	92336-20	317287	4924499	95	Big Dam/Still Water portage
wP4	White Pine	88312-215	305456	4913575	115	Poplar Lake
wP5	White Pine	92336-127	315938	4912169	115	Duck Pond Brook
BURN1	White Pine	92336-14	311960	4924451	110	North of Frozen Ocean cabin
BURN2	White Pine	92341-5	315631	4907053	105	On Otter Brook Road
BURN3	Mixed Wood	92339-209	324323	4911359	90	Off coast of George's Lake

Appendix R - Review of provincial newspapers reports

The province of Nova Scotia has documented all of its fires through a scrapbook collection of relevant newspaper articles. Newspaper reports (from the *Star*, *Herald*, and *Chronicle* newspapers) from 1934 – 1953, as applicable to the Kejimikujik region, are summarized below. The particular scrapbook (e.g. Book 1) where each fire was documented is given.

Note: There appears to be a span of three years from 1949 to 1951 when either little fire activity occurred or it was not recorded.

Book 1 May 19, 1934 - January 12, 1935

1. +Herald

Caledonia, Queens Co.

May 18, 1934

Brush fire near fox ranch of A.B. Murley. No details regarding fire behaviour or area burned was given.

2. +Star

May 31, 1934

"Forest fires are burning all over the province; the seriousness of the situation cannot be over-emphasized." Forests of Nova Scotia closed to public travel from June 2 to July 20, 1934, unless with a permit, (excluding Cape Breton). Issued by J.H. Macquarrie, Attorney General of Nova Scotia. "No travelling, camping, fishing or picnicking unless duly authorized by a local forest ranger...such notification of route, destination, purpose and duration of trip with dates must be given."

3. +Herald

June 11, 1934

All forest fires in Nova Scotia were reported to be "under control"

Book 2 January 14, 1935 - August 24, 1935

4. +Chronicle

March 29, 1935

Expenditure for Lands and Forests in 1934 was "high" for Nova Scotia, owing to the "exceptional dryness and abnormal cost of fighting forest fires." Total expenditure was estimated at \$155,380 compared to a predicted cost of \$140,700 for 1935, a decrease of nearly \$15,000.

5. +Herald

June 12, 1935

It was reported that there was a decrease of 15% in fire losses in Canada compared with the same time in 1934, probably due to progress in fire prevention. The following is a break down of the reported provinces' national standing in preventing fires:

Ontario: 35% decrease of the Canadian total

British Columbia: second place with 15%

Quebec: 2%

Nova Scotia and New Brunswick: kept same average as in 1934 (the average was not recorded).

Prince Edward Island: "practically a fireless record."

Book 4 May 9, 1936 - February 10, 1937

6. +Herald

Caledonia, Queens Co.

May 27, 1936

Four hundred volunteer fire fighters helped put out a fire which burned more than 125 acres of timberland, near north Brookfield and spread toward Pleasant River Road, the main highway between Bridgewater and Caledonia.

7. +Herald

Caledonia, Queens Co.

June 3, 1936

"Fire fighters prevented today what might easily have been one of the worst forest fires in the history of this part of the province." The fire occurred near Dean Lake, about a mile and a half from DeLong Settlement, however, it was reported that an area of only 25 acres was burned.

8. +Herald

June 4, 1936

The following is an example of fire prevention propaganda which was prevalent in newspapers around this time; newspapers report fires as "angry red monsters" or "fiery

demons". "Last year in Nova Scotia, fishermen caused 31 fires, travellers and campers 16, smokers 51, children 21, berry-pickers 39, brush burners 32. The responsibility for 121 others is unknown but 59 definitely were deliberately set." "There is one penalty suitable for the incendiaries and that is prison." "Not fire, but the owner of the hand that lights it, is the public's enemy."

Book 5 February 11, 1937 - August 31, 1937

9. +Herald

May 31, 1937

Department of Mines and Resources reported that more than 80% of Canadian forest fires are a result of man's carelessness. In 1936, three million acres of timber at a value of \$6,080,000 were destroyed by fire. The cost of actual fire fighting for 1936 reached \$1,200,00.

10. +Herald

Brookfield Mines, 8 miles from Caledonia, Queens Co.

June 4, 1937

A "dry spell" of weather and high winds helped initiate a fire which started in brush and destroyed the property of United Gold Fields Ltd. Origin of fire and area burned not reported.

Harmony Mills, 3 miles from Caledonia

June 4, 1937

Fire broke out in an old timber cutting, three quarters of a mile affected. Fire origin unknown.

Rossignol district, 12 miles from Caledonia.

"Heavy" fire broke out a half mile from Rossignol Lake and burned through old timber cuttings. It took 2 hours to put the fire out and "several miles square" were affected.

Book 6 August 23, 1937 - June 9, 1938

11. +Herald

Caledonia, Queens Co.

May 9, 1938

Three hundred acres of young growth woodland were destroyed between Westfield and DeLong Settlement when a fire started on Rossette Road. It is believed someone set the fire.

Book 7 June 10, 1938 - March 21, 1939

12. +Herald

Caledonia, Queens Co.

June 12, 1938

A forest fire started a mile east of Tupper Lake, North Brookfield District and burned 400 acres, leaving 125 cords of Charleston Pulp and Paper in ruins. Rain prevented the fire from spreading to timber in Long Lake and Round Lake areas. It is believed the fire was of incendiary origin.

13. +Herald

October 10, 1938

"During the last five years the number of fires, many of them small, has shown a steady increase. For the five year period 1921-1925, the average number of fires in Nova Scotia was 1166. By 1937 the figure climbed to 1694, the highest ever recorded."

Fire losses during this same period have decreased, however. In 1921, loss was \$5.86 per capita, whereas the period from 1935-1938 a loss of \$2.34 per capita was incurred.

The years 1919-1921, average annual fire loss of Canada was \$80 million; in 1922, it is estimated \$54,500,000. "Each succeeding year has seen a decline and for the last three years actual loss has average \$22,500,000. *The number of small fires has increased, but large fires have dropped in number.* Before 1922, half of Canada's fire loss occurred in less than 1% of the fires; these conflagrations wiped out cities, towns and villages."

In 1921 there were 23 million dollar fires; in 1922, there were 25. Since 1926, however, there have only been 2 such fires.

During the past 10 years (1928-1938), consumption of tobacco in Canada has increased and the number of fires has grown simultaneously. In 1925, there were 1,402 fires due to careless smoking and in 1937 the number increased to 12,963.

Book 9 March 18, 1940 - June 10, 1941

14. +Star

July 2, 1940

A 60 foot steel observation tower at West Caledonia, Queens Co. was raised by Department of Lands and Forests in an attempt to guard against fire outbreaks. With its

aid, fire fighters and equipment are expected to arrive on the scene of a fire within 5 hours.

Book 10 June 11, 1941 - January 2, 1943

15. +Herald

Lake Rossignol

July 18, 1942

Forest fire swept through the Lake Rossignol area, through the "heart of timber country" owned by the Mersey Pulp and Paper Company. At its height, the fire had a 4 mile front and covered 9 square miles, however, it was reported to have burned only light brush and scrub timbers.

Fire was also reported in the wild game sanctuary in the Tobeatic. Billows of smoke could be seen across the northern horizon from Shelburne. Extent of fire was not known.

16. +Herald

Tobeatic

July 20, 1942

Burning over a wide area between Roseway Lake and the Tobeatic Game Reserve, a fire has developed into one of the "most serious" in the province. The reason for the fire was reported as due to improper clearing after limbering operators.

Book 11 1943 - 1944

17. +Chronicle

March 16, 1943

There were 292 fires in 1942, which burned an area of 28 119 acres. Of these fires, 231, or 79% were extinguished before exceeding an area of 10 acres and only 3 fires exceeded 500 acres.

18. +Star

March 14, 1944

Forest loss due to fire in 1943 "was the smallest in more than a quarter of a century" (Dept. of Lands and Forests). Acreage burned was 1940, the lowest since 1917. There were only 101 woodland fires.

19. +Chronicle

Caledonia, Queens Co.

May 10, 1944

Fire destroyed a house, barn and outbuildings belonging to a Maitland Bridge resident, as well as a large area of undergrowth. The fire was brought under control before it did any "serious damage" to woods or other homes.

Fire behaviour and origin not reported.

20. +Herald

Caledonia, Queens Co.

May 16, 1944

Fire of unknown origin broke out in brush near the highway at Centrelea. During the afternoon fire was also reported "some distance away" but was stopped before it could reach any buildings. Another fire was reported in the district of Lake Rossignol but the extent of the blaze was not learned.

Book 12 May 22, 1944 - July 25, 1945

21. +Chronicle

South Brookfield, Queens Co.

June 15, 1944

A \$400,000 bucket and box factory, Nova Scotia Woodenwares Ltd., was destroyed by fire. The fire started from a hot box and fanned by a north wind, swept across a river toward downtown South Brookfield.

22. +Daily Star

June 29, 1944

14,460 fires in 1943 were reported to have been the result of careless smokers.

23. +Herald

July 13, 1945

In the first half of 1945, Nova Scotia experienced 50 fires (G.W.I. Creighton, Chief Provincial Forester).

Book 14 July 1946 - November 1946

24. +Herald

Caledonia, Queens Co.

July 1, 1946

The Mersey Paper Company property experienced a forest fire due to an electrical storm. Approximately 500 acres of timberland in the Lake Rossignol area, 1 mile west of Irving Lake, and about 100 acres of adjacent Crown Land, were destroyed.

25. +Chronicle

Caledonia, Queens Co.

July 18, 1947

Three hundred thousand feet of sawn and piled lumber at the cost of over \$25,000 were destroyed at Mason's Sawmill on Sand Lake, Caledonia. The fire started at 3:00 pm and ended "by dark". It is believed the fire was caused by cigarette or pipe embers.

Book 16 February 3, 1948 - December 7, 1948

26. +Chronicle

April 1, 1948

Nova Scotia experienced the heaviest forest fire losses in 13 years during 1947. Four hundred forty-four fires burned approximately 45000 acres of land, with 14 of these fires doing the most damage. One-third of these fires were caused by careless smokers.

The causes of the 444 fires is as follows:

Lightning	3
Burning Bush	12
Berry Pickers	49
Railways	18
Sawmills and Industrial	12
Children	28
Smoking	38
Incendiary	53
Travellers and campers	63
Burning buildings	12
Fishermen	42
Unknown	14

Book 20 August 1, 1951 - August 31, 1953

27. +Chronicle

South Brookfield, Queens Co.

July 8, 1952

Forest fire in South Brookfield, Queens Co., was the result of careless fishermen or persons roaming in the woods. Fire behaviour and area burned was not reported.

Appendix S - Available Parks Canada fire reports for KNP, 1968-2000

DEPARTMENT OF NORTHERN AFFAIRS AND NATIONAL RESOURCES

NAME 10-103

INDIVIDUAL FOREST FIRE REPORT

CLASSES OF FIRES

A - Less than 1 acre.
B - 1 acre to less than 10 acres.
C - 10 acres to less than 100 acres.
D - 100 acres to less than 500 acres.
E - 500 acres and over.

INSTRUCTIONS - Fill in this form in duplicate for each fire as carefully and completely as possible as soon as the required information is available. Do not depend for much on memory; interview surviving conscientiously. The information you supply will be used for research purposes to help you and others in planning fire lines, etc. for the purpose of the fire as far as possible. (Include names of persons involved, including members, company, old burn, etc.) as accurate as possible. If possible, show unit and place of fire when first discovered and when fire-fighting commenced. Keep one copy of each completed form and send the others to your superior officer without delay.

National Park, or Warden District: Kajikjick National Park Class: A

NAME OF FIRE: Mountain Lake Time fire started: 1630 hrs. 23 Aug. 68

LOCATION: Mountain Lake Map ref. 198108 Fire No.: 1

Name of Reporting Officer: R.W. Buchanan, Warden

CAUSE, DISCOVERY AND ACTION TAKEN:

Specific Cause (source of ignition): Lightning

General Cause (agency responsible): Lightning

Classified Cause: Lightning

Who discovered it: Fire tower observer When: 1630 hrs. Size of fire then: .06 Ac.

What action did he take? Reported to Chief Warden Munroe

When did Reporting Officer get there? 1800 hrs. 23 Aug. 68 What action did he take? Set up

Water fire pump

Distance Reporting Officer travelled to fire: Car 12 miles.

Horseback 1 miles. Etc. 1 miles. Total 13 miles.

Distance from Headquarters to fire: 13 miles. Details of prosecutions (if any): 0

DETAILS OF FIRE FIGHTING:

Time fire-fighting commenced: 1830 (Hour) 23 Aug. 68 (Date) Size of fire then: .06 Ac.

Time fire under control: 1915 (Hour) 23 Aug. 68 (Date) Size of fire then: .06 Ac.

Time completely extinguished: 2100 (Hour) 23 Aug. 68 (Date) Time patrol stopped: 1200 hrs. 28 Aug. 68

Perimeter of fire when fire-fighting commenced: 1000 yd.

Perimeter when controlled: 100 yd.

Fireguards:—Constructed by hand (1) 0 yd. By horse plough (2) 0 yd.

By other power (3) 0 yd. Line held by pumps only (4) 100 yd.

Trail or natural guard back-fired (5) 0 yd. Total line lost (6) 0 yd.

Total line held (7) 100 yd. Constructed guard back-fired: 0 yd.

Number of men employed: 80 Rate per hour: various men per cents

Total man-hours actually on fire-line construction: 0

What class of men were obtained and where? Park project crews

How many were paid by this Department? 20

How many were paid by other organizations? 0

Distance men travelled to fire: Car 104 miles. Horseback 1 miles. Etc. 1 miles.

Total 20 miles. How long did it take to get men and take them to fire? 14 hours.

Method of fighting fire, and equipment used: Water bucket (Dept. of Lands & Forests, etc.)

1 Water fire pump, 3 back tanks, 3 shovels.

Equipment lost or destroyed: 0

DESCRIPTION OF FIRE BEHAVIOUR:
Material in which fire started, if known..... apparently dead trees struck by lightning.
(Open, leaf litter, etc. Describe type of forest or other land at point of fire.)

Material in which fire started, if known

(Grass, leaf litter, etc. Dominant type of forest or other land use point of origin.

(including species, size and density of trees, amount of stock, ground vegetation, etc.)

Principal fuels in which fire spread..... Leaf litter and laurel.
(Leaf litter, moss, slash, etc. Note depth of burn in ground. If fire travelled as oil in tree crowns, state species and density of stand, and time of crowning)

 If an accident into types different from this in which it started, describe them types as in previous question)

Nature of soil and topography **rocky, shallow soil**
(Was forward construction easy, moderately hard, or hard?)

Rate of spread of fire **slow** (slow, moderate, fast or very fast, for this type of insect or insect)

Difficulty of control of fire..... (Easy, sometimes hard, or very hard, for this time of season or season)

Sinouldering after control

Spot or jump fires

If the fire burned for two or more days, show, in the space below, the estimated rate of spread and estimated difficulty separately for each day if possible, and state the forest type or types burned. Note under "Remarks" any fire-uses at night or other unusual features.

Date	Danger Index	Form Type	Speed of Advance	Contact Difficulty	Remarks
		N/A			

DAMAGE:

Land burned within National Park, Forest Experiment Station, or Warden District boundary:

[illegible]

N.B. — Timber values vary with the species and location of the stand. Use figures suited to your district as supplied by your nearest office.

Timber conditions on this area before fire: *M ft. b.m. Cords
Per cent of timber killed..... What per cent of area burned was well stocked with seedlings of
merchantable species?

Was soil damage light, moderate, or severe?.....light

Area burned in this fire outside National Park, Forest Experiment Sta., or Warden Distr. boundary.....Ac.

COST OF EXTINGUISHING:

Hired labor	Provisions and supplies	Freight and Transportation			Total Columns 1 to 4	Warden labor	Other Government Labor	Tools lost or damaged	Total Cost Columns 2 to 9
		Men	Trucks	Miscellaneous					
1	2	3	4	5	6	7	8	9	
	13.69				13.69		145.95		145.95

FATHER AND MISCELLANEOUS:

Weather conditions and Danger Index..... Clear, U.S. Danger Index 0

(Notes particularly strength and direction of wind, and occurrence of rain, if any)

General Remarks ~~This fire apparently started from a lightning strike in early morning~~

Aug. 68 and murdered until melted by fire tower chimney at 1630 hrs. 23 Aug. 68.

Signature of Reporting Officer:

Signature of Reporting Officer: L.W. Beckman
 Title: Post Master

Date of this report 30 March 1968 Page 1 of 1

TM & Co. is a 100% stock owned company.

DEPARTMENT OF INDIAN AFFAIRS AND NORTH-WEST DEVELOPMENT

FAST FIRE REPORT (SHORT FORM)
COMPLETE FOR ALL SMOKE REPORTS INVESTIGATED

PRELIMINARY
For fires Classes B, C, C₁, C₂, D ☐

LOCATION
Kajikujik National Park

DISTRICT
Public Responsibility Area

FIRE Reported at
A.M. **1400 P.M. Aug. 25, 19 69**

By
Ground Patrol ☐ Aircraft ☐ Other ☐
Lookout ☒ Railroad ☐

REPORTING OFFICER ARRIVED AT
A.M. **1710 hrs. Aug. 25, 19 69**

SUPPRESSION BEGAN
A.M. **1800 P.M. Wardens Buchanan & Reuter**

FIRE LOCATION (Pinpoint by local description - No fire map required)

East side George Lake. Map Reference 243-115, Sheet 21A/6East, Kajikujik Lake.

IMMEDIATE ACTION TAKEN BY PATROL

Handtools ☐ Fire Pump ☒ Chainsaws ☐ Trailer Pump ☐ Water Tank ☐ No. of men ☐ **2**

Others (Describe)

FIRE UNDER CONTROL
A.M. **1800 P.M. Aug. 25, 1969**

FIRE OUT
A.M. **1830 P.M. Aug. 25, 1969**

CLASSIFIED CAUSE

Recreation ☐ Woods Operations ☐ Railroad ☐
Setfire ☐ Other Industries ☐ Incendary ☐
Unknown ☐ Misc. Known ☐ Lightning ☒

PATROL AFTER CONTROL
From: **0800** To: **1100**
A.M. **0800** P.M. **1100**

ADDITIONAL DETAILS ON CAUSE

Severe electrical storm which began 1500 hrs., ended 1630 hrs.

COST OF EXTINGUISHING (For Warden Office Records): NOTE: Not required in preliminary report on fires Class B, C, C₁, C₂, D.

MEN OBTAINED FOR FIRE FIGHTING				DEPARTMENTAL VEHICLES USED			
No.	Hours	Rate	Amount	No.	Hours	Rate	Amount
Warden I				Patrol Vehicle	2	\$1.20	\$2.40
Warden II	2	\$6.00	\$12.00	Tank Truck			
A/Warden							
TOTAL COST							\$12.40

FOREST TYPE IN IMMEDIATE AREA

AGE: Mature ☐ Young Timber ☐ Reproduction ☒ Mixed ☐

Canifers ☐ All ☐ **50** DECIDUOUS ☐ All ☐ **30**

Cutover ☐ Grass ☐ Did burn ☐ Other (specify)

SPECIFIC FUEL BURNED

ON SURFACE AND OR SINCE ON SURFACE

Bark ☐ Duff ☐ Grass ☐ Twigs ☐ Moss ☐ Other ☐ Branches ☐ Trunk ☒ Reproduction ☐ Other ☐

GROUND CONDITIONS

Rock Outcrop ☐ Shallow Soil ☒ Deep Soil ☐ Sand or Gravel ☐ Loom ☐ Clay ☐ Moist ☐ Dry ☐ Depth of Burn ☐ **0**

WIND VELOCITY **15 gusts to 30** DANGER INDEX **12** WIND FROM **West**

REMARKS
This fire was confined to the trees, one white Pine approx. 15" D.B.H. and one Red Oak, approx. 8" D.B.H. The fire was extinguished before it had time to spread.

SIGNATURE OF REPORTING OFFICER
W. Buchanan

DEPARTMENT OF NORTHERN AFFAIRS AND NATIONAL RESOURCES
BEST FIRE REPORT (SHORT FORM)
 COMPLETE FOR ALL SMOKE REPORTS INVESTIGATED

PRELIMINARY
 For fires Classes B, C, C₁, C₂, D ☐

LOCATION: **Kojimukujuk National Park** DISTRICT: **Headquarters**

FIRE Reported at: **13125 July 26, 1970** P.M.
 By: ☒ Ground Patrol ☐ Aircraft ☐ Other ☐
☐ Lookout ☐ Railroad

REPORTING OFFICER ARRIVED AT: **13130 July 26, 1970** P.M.
 SUPPRESSION BEGAN: **13130** P.M. By: **Warden McInnis**

FIRE LOCATION (Pinpoint by local description - No fire map required)
Fairy Rocks picnic site, approximately 200' from lake shore, in sawdust pile.

IMMEDIATE ACTION TAKEN BY PATROL
 Handtools ☒ Fire Pump ☒ Gasoline ☐ Trailer Pump ☐ Water Tank ☐ No. of men
 Others (Describe):

FIRE UNDER CONTROL: **13145** P.M. FIRE OUT: **14130** P.M.
 CLASSIFIED CAUSE: ☒ Recreation ☐ Woods Operations ☐ Railroad ☐
☐ Settlement ☐ Other Industries ☐ Incendary ☐
☐ Unknown ☐ Misc. Known ☐ Lightning ☐

From: **13145** P.M. To: **14130** P.M.
July 26 **July 27**

ADDITIONAL DETAILS ON CAUSE
Caused by cigarette butt thrown in sawdust.

COST OF EXTINGUISHING (For Warden Office Records): NOTE: Not required in preliminary report on fires Class B, C, C₁, C₂, D.

MEN OBTAINED FOR FIRE FIGHTING	No.	Hours	Rate	Amount	DEPARTMENTAL VEHICLES USED	No.	Hours	Rate	Amount
Warden I		2	2.92	\$5.84	Patrol Vehicle	B410	2	1.20	2.40
Warden II		1	3.20	3.20	Patrol vehicle	B412	1	1.20	1.20
A/Warden									
TOTAL COST									12.00

FOREST TYPE IN IMMEDIATE AREA
 AGE: Mature ☐ Young Timber ☐ Regeneration ☒ Mixed ☐
 Canopies: All ☐ or ☒ DECIDUOUS ☐ All ☐ or ☒ ☐
 Cutover ☐ Grass ☐
 Old burn ☐ Other (specify):

VALUES LOST (Not required in preliminary report)
 \$ Killed DBM Height
 Mft b m cords

SPECIFIC FUEL BURNED
 a) ON SURFACE **sawdust** b) NOT ON SURFACE
 Bark ☐ Duff ☒ Grass ☐ Twigs ☐ Moss ☐ Other ☐ Brush ☐ Shrub ☐ Reproduction ☐ Trunk ☐ Branches ☐ Roots ☐ Other ☐

GROUND CONDITIONS
 Rock Outcrop ☐ Shallow Soil ☒ Deep Soil ☐ Sand or Gravel ☐ Loam ☐ Clay ☐ Moist ☐ Dry ☐ Depth of Burn

WIND VELOCITY: **S. - 15-20 m.p.h.** DANGER INDEX: **10** WIND FROM: **S.W.**

REMARKS:
Immediate suppression prevented fire from spreading to forested areas.

SIGNATURE OF REPORTING OFFICER: **A.C. McInnis**



Maitland Bridge, Anna. Co., N.S.
25 April 1973.

CENTRAL REGISTER

REFERRED TO

04/5-F1

Director,
Atlantic Region.

APR 27 1973

Attention: Mr. A.D. Brown

FILE NO

64/5-F12

REMARKS ON

Mount Tom Brook Fire

On April 17, 1973, we received a radio call at the Park Office from the Park Fire Tower. The towerman had spotted smoke at bearing 334° at Mount Tom Brook, time of the call was 3:40 P.M. The Chief Park Warden contacted the Department of Lands and Forests, at McGowan Lake by phone for assistance. The plane was made ready immediately, and a radio was dispatched from the Park Office to McGowan Lake for the pilot. The pilot commenced to dump water at 4:20 P.M. and a total of thirteen loads was dropped on the fire. He was forced to stop, due to wind and rough water on Kedge Lake. We had a cross-bearing from the Provincial Tower of 280° which pin-pointed the fire on the first given reading from the Park Tower.

Twelve men from our Park forces crossed Kedge Lake by boat and started to the area of the fire, but due to the difficult walking and approaching darkness, had to come back before reaching the fire.

On April 18, two crews were dispatched from the Park Compound with hand tools and back tanks, at 5 A.M. Warden Rowter crossed the Lake with five men and reached the scene of the fire at 7 A.M. Warden Buchanan, travelled from the Fire Tower with four men and reached the fire at 7:20 A.M. They commenced suppression immediately.

The Superintendent, and Chief Park Warden flew over the fire at 7:30 in the Department of Lands & Forest plane, at which time the fire appeared to be completely under control. The Operations Manager made arrangements to have a helicopter from Dartmouth proceed to the Park to take in food and sleeping equipment for the fire crews.

Warden Rowter and Warden Buchanan continued to patrol the fire with their crews to extinguish all hot spots, until approximately 9:00 A.M. Both crews remained on the fire until 3:00 P.M. the 19th of April, at which time they were flown from the fire site by helicopter.

.. / 2

Weather

On April 17, we had humidity of 32%; Northwest wind of 14 M.P.H., under sunny skies.

Equipment

There was no loss of equipment and no injuries to the men fighting the fire.

The fire burned over an area of twenty-five acres. There was very little damage to the trees, and it was considered a flash fire on the ground. Fire depth in the ground was approximately four inches.

Fuel

Fuel consisted of leaves and twigs. Trees in the area that burned consisted of oak, white birch and sugar maple, with a few scattered pine along the edge of the bog.

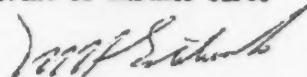
Fire was believed to have been started by two fishermen from Halifax, one of whom is a member of the Halifax Fire Department. Due to the fast action of the water-bomber, the fire was kept under control on the evening of 17 April. This made the suppression of the fire much easier for the Park Fire Crews on 18 April.

Note:

There was no charge for the water-bomber, or for the service we received from the helicopter. The Park is most grateful for their services.

All other fire suppression was carried out by Park forces on the Mount Tom Brook Fire.

Our Spring Fire Season, is a month ahead compared with this time last year. All equipment and Park forces are ready in the event of another fire.



For: G. C. Myers,
Superintendent,
Kojinkujik National Park.

DEPARTMENT OF NORTHERN AFFAIRS AND NATIONAL RESOURCES

INDIVIDUAL FOREST FIRE REPORT

MANR 10-138

Note—In addition to this form report will be sent to the nearest fire station within 100 miles of the place of origin of the fire. This report is to be used for research purposes to help you and others in the future.

INSTRUCTIONS—Fill in this form in duplicate for each fire as carefully and completely as possible as soon as the required information is complete. Do not depend too much on memory; re-examine everything conscientiously. The information you supply will be used for research purposes to help you and others in the future. Each report must be accompanied by a map of the fire on form MANR 10-138A, showing different forest types burned (including tundra, swamp, old burn, etc.) as accurately as possible. If possible show size and shape of fire when first discovered and when fire-fighting commenced. Keep one copy of each completed form and send the others to your supervisor officer without delay.

National Park, or Warden District... Kojikujik Class C (See below)

NAME OF FIRE... Mount Tom Brook Time fire started... 3:40 p.m. Apr. 17, 1973 (Hour and date, as clearly as possible)

LOCATION... Latitude 44°22.2' Longitude 65°17.5' Fire No. 1

Name of Reporting Officer... Jordan Wentzell Park Warden (If other, Warden, etc., in charge of crew on this fire)

CAUSE, DISCOVERY AND ACTION TAKEN:

Specific Cause (source of ignition)... not known (Match, pipe, land, cigarette, cigarette, slash or debris fire, engine spark or ash, lightning, etc.)

General Cause (agency responsible)... fisherman (Boat, motor, submarine, trapper, prospector, miner, berry picker, road worker, forest worker, tourist, railway, aircraft, etc.)

Classified Cause... smokers (Classify under one of the following standard headings: cigarette, smokers, articles (give reason for burning), matches, lightning, industrial operations (describe), incendiary (state probable object), public works (describe), abandoned (describe), unknown. Do not classify as "unknown" if you have any clue as to cause.)

Who discovered it? Park Warden When? 3:40 p.m. Apr. 17/73 Size of fire then A Ac. (Describe air or ground patrol, public, etc.)

What action did he take? Called Park Office What action did he take? (Date)

When did Reporting Officer get there? 7 a.m. Apr. 18/73 (Hour) (Date)

Patrol Perimeter of fire, check for hot spots

Distance Reporting Officer travelled to fire: Car 4 miles

Horseback 9 miles Etc. 5 miles Total 9 miles

Distance from Headquarters to fire 9 miles Details of prosecutions (if any) nil

(Give particulars as to guilty persons, convictions, fines, etc.)

DETAILS OF FIRE FIGHTING:

Time fire-fighting commenced 4:20 p.m. Apr. 17/73 Size of fire then 3 to 4 Ac. (Hour) (Date)

Time fire under control 7:30 a.m. Apr. 18/73 Size of fire then 25 Ac. (Hour) (Date)

Time completely extinguished 9:00 a.m. Apr. 18/73 Time patrol stopped 2 p.m. Apr. 19/73 (Hour) (Date)

Perimeter of fire when fire-fighting commenced 500 yd.

Perimeter when controlled 1800 yd.

Fireguards:—Constructed by hand (1) nil yd. By horse plough (2) nil yd.

By other power (3) nil yd. Line held by pumps only (4) nil yd.

Trail or natural guard back-fired (5) nil yd. Total line lost (6) nil yd.

Total line held (7) nil yd. Constructed guard back-fired nil yd.

Number of men employed 20 Rate per hour Park rate cents (Sum of items 1 to 5 should equal item 6 plus item 7)

Total man-hours actually on fire-line construction 312

What class of men were obtained and where? Park employees only (Construction or logging crew, soldiers, Indians, casual labour, etc.)

How many were paid by this Department? all

How many were paid by other organizations? nil (Name of railway company, motor company, fire-fighting service, etc.)

Distance men travelled to fire: Car 4 miles Foot 2 miles Etc. 3 miles

Total 9 miles How long did it take to get men and take them to fire? 1 1/2 hours

Method of fighting fire, and equipment used... Water-bomber, Back tanks, shovels.

Notes: Fire held by Provincial water bomber (Parker Avenue)

Equipment lost or destroyed... nil

DESCRIPTION OF FIRE BEHAVIOUR:

Material in which fire started, if known: leaf litter (leaf litter, moss, slash, etc. Describe type of forest or other land at point of origin.)

Principal fuels in which fire spread: leaf litter (leaf litter, moss, slash, etc. Note depth of burn in ground. If fire involved all in tree crowns, state species and density of stand, and time of crowning.)

Nature of soil and topography: rough and very rocky (Was ground construction easy, moderately hard, or hard?)

Rate of spread of fire: fast (Slow, moderate, fast or very fast, for this type of forest or land)

Difficulty of control of fire: moderate (Easy, moderate, hard, or very hard, for this type of forest or land)

Smouldering after control: easy (Easy, moderately hard, or hard to extinguish. Did it last till rain fell?)

Spot or jump fires: nil

If the fire burned for two or more days, show, in the space below, the estimated rate of spread and control difficulty separately for each day if possible, and state the forest type or types burned. Note under "Remarks" any fire-ups at night or other unusual features.

Date	Danger Index	Forest Type	Speed of Advance	Control Difficulty	Remarks

DAMAGE:

Land burned within National Park, Forest Experiment Station, or Warden District boundary:

No. of acres	Forested Land (Note species of timber, age, size density, etc.)	Area burned, in acres	Timber Conditions								Total Loss
			Salvable			Unsalvable					
			Under present marketing and operating conditions								
			*M ft. b.m.	Cords	Loss by depreciation	*M ft. b.m.	Cords	Loss			
	Merchantable timber <u>Flash Fire</u>	<u>no damage to tree growth</u>									
	Cut-over timber										
	Young growth										
	Non-Forested Land										
			Total	Total	Total	Total	Total	Total	Total	Total	Total
	Old or new burn, non-reproducing		Other property destroyed: buildings, fences, logs, lumber, grass, roads (not fire-fighting), etc. Ownership, date ownership, if possible, and salvage value:— <								

Other property destroyed: buildings, farms, loss, timber, grain, etc. (not fire-killed), etc. Describe, state quantity, if possible, and rough value.

Total value of other property destroyed, (C)

Grand total of loss from (1) and (2)

*M.—Timber values vary with the species and location of the stand. Use figures listed in your district as supplied by your superior officer.

Timber conditions on this area before fire: *M ft. b.m. 3,000 Cords 20

Per cent of timber killed: no kill What per cent of area burned was well stocked with seedlings of merchantable species? 10 %

Was soil damage light, moderate, or severe? light

Area burned in this fire outside National Park, Forest Experiment Sta., or Warden Distr. boundary nil Ac.

COST OF EXTINGUISHING:

Hired labour	Provisions and supplies	Freight and Transportation			Total Columns 1 to 5	Warden labour	Other Government Labour	Train fuel or damages	Total Cost Columns 6 to 9
		Miles	Tons	Months/years					
1	2	3	4	5	6	7	8	9	
\$1,553.18	\$73.00	nil	nil	nil	\$1,626.18	\$230.96	nil	nil	\$1,857.14

WEATHER AND MISCELLANEOUS:

Weather conditions and Danger Index Fire hazard index was high - wind NW 14, had no rain for 7 days: woods were very dry. (Note particularly strength and direction of wind, and occurrence of rain, if any)

General Remarks: Due to the fast action of the Lands & Forests water-bombard, the suppression of this fire was made much easier and quicker.

Signature of Reporting Officer:

Title: Park Warden

Date of this report

May 2

1972

DEPARTMENT OF NORTHERN AFFAIRS
LAND AND NATIONAL RESOURCES

FIRE MAP

INSTRUCTIONS: This fire map must accompany written report on form NARS 10-126 for all fires. Complete the heading carefully to correspond with that on form NARS 10-126. Show by an "X" WHERE THE FIRE STARTED. Show also other directions where the timber, young growth, meadow, grass lands, etc. were located and where fire guards constructed. Use a scale suitable to show detail and specify scale in space provided below.

NATIONAL PARK, FOREST EXPERIMENT STATION OR WARDEN DISTRICT

Kejimikook National Park

NAME OF FIRE (SAME AS ON ACCOMPANYING REPORT)

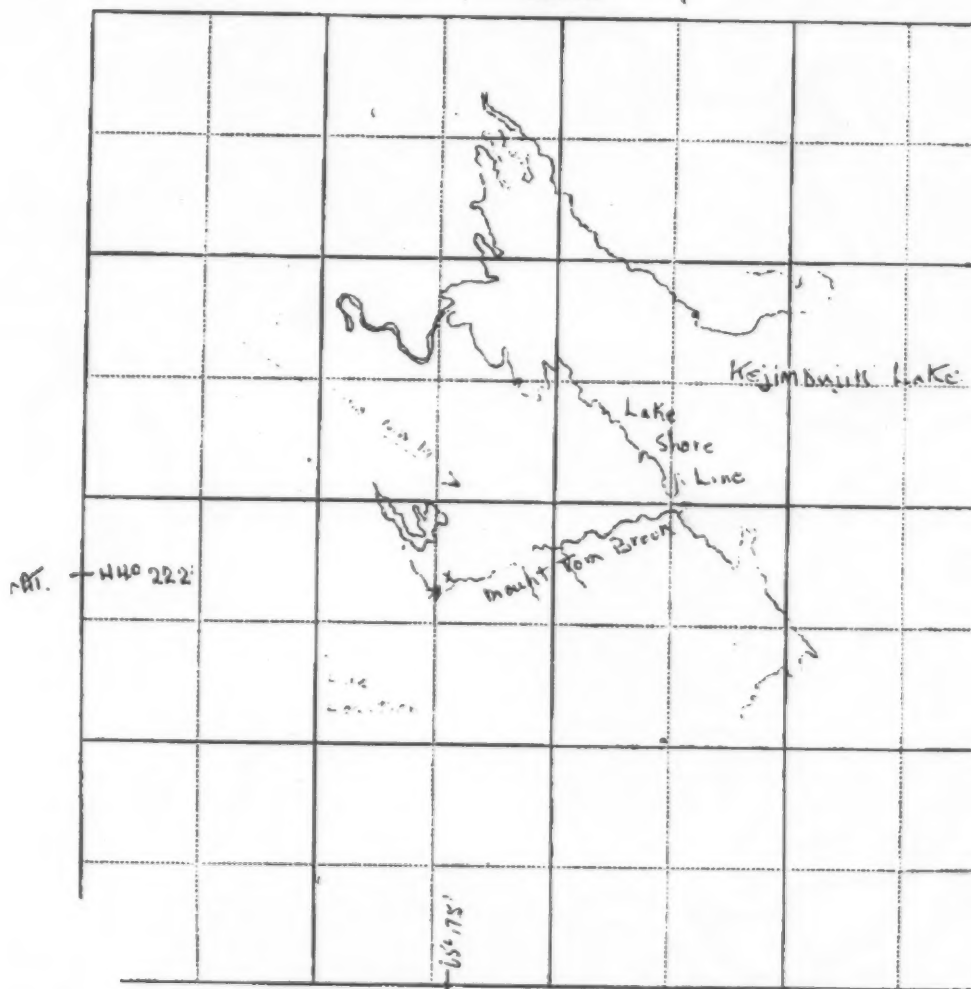
Mount Tom Brook

FIRE NUMBER

1

LOCATION (LOCATE BY SECTIONS, ETC., WHERE APPLICABLE OTHERWISE LOCATE AS WELL AS POSSIBLE)

NORTH



Scale: 1:50,000

REPORTING OFFICER

TITLE

10-126A

MAITLAND BRIDGE, Anna. Co., N.S.
19 June 1973.

Director,
Atlantic Region.

Attention: Mr. A.D. Brown

Forest Fire Report

For the information
Of the information

04/57
CENTRAL REGISTRY
REFERRED TO 22/11/73

JUN 19 1973

NO 045-512

SEARCHED IN

- - Forest fire report forms # 10-135 and 10-135A are enclosed and cover a small fire which occurred on June 8, 1973. The fire was detected by our towerman at 5:45 P.M. June 8, 1973. On arrival, Chief Warden Roper discovered that two fires were burning and were approximately 100 feet apart and contained in two dead brush piles. The fires were extinguished soon after. Fast action by the Warden staff prevented spread of the fire.

Because of the suspicious origin, the R.C.M.P. were contacted and investigated. The fire broke out when our staff were at home, the temperature was 83°F, woods were dry and wind was present. Because of the dense growth between each fire location, it was impossible that one was ignited from the other and both were of the same size.

Neither the Wardens or the R.C.M.P. found any other evidence or clue to the origin of the fire. If additional evidence or clues are uncovered, we will advise.

G. C. Myers
For: G. C. Myers,
Superintendent,
Kojimujik National Park.

DEPARTMENT OF NORTHERN AFFAIRS AND NATURAL RESOURCES

INDIVIDUAL FOREST FIRE REPORT

MANR 10-125

Note.—In addition to this form report and any fire which start within 500 feet of the right of way on special form 505, "Railway Fire Only", provided by the Board of Transport Commissioners, Ottawa.

CLASSES OF FIRE

- 1—Less than 1 acre.
- 2—1 acre to less than 10 acres.
- 3—10 acres to less than 100 acres.
- 4—100 acres to less than 500 acres.
- 5—500 acres and over.

INSTRUCTIONS.—Fill in this form in duplicate for each fire as carefully and completely as possible as soon as the required information is complete. Do not depend too much on memory; investigate everything conscientiously. The information you supply will be used for research purposes to help you and others in reducing fire losses; so careful view for this purpose depends on the accuracy of your report.

Each report must be accompanied by a map of the fire on form MANR 10-126, showing different forest types burned (including meadow, swamp, old burn, etc.) as accurately as possible. If possible show area and square of fire when first discovered and when fire-fighting commenced.

Keep one copy of each completed form and send the others to your superior officer without delay.

National Park, or Warden District Kojimukjik National Park

Class. A

(See letters above)

NAME OF FIRE Canning Field Road Fire

Time fire started 5:45 P.M. June 8 1973

LOCATION Latitude 44°24.10' North, Long -65°12.35'W

(Fire and date, as nearly as possible)

Fire No. 2

Name of Reporting Officer Ben H. Roper

(Forester, Warden, etc., in charge of crew on this fire)

CAUSE, DISCOVERY AND ACTION TAKEN:

Specific Cause (source of ignition) Match

(Match, pipe heat, cigarette, campfire, chain or electric fire, machine spark or rock, lightning, etc.)

General Cause (agency responsible) Set by man deliberately

(Butter, lamp, lantern, toaster, projector, motor, battery plunger, road worker, forest worker, hunter, railway, aircraft, etc.)

Classified Cause Man Township

(Classify under one of the following standard headings: campfire, smokers, settlers (give reason for burning), railways, lightning, industrial operations (describe), machinery (state probable source), public works (describe), unclassified (describe), unknown. Do not classify as "unknown" if you have any clue as to cause.)

Who discovered it? Townman

(Landowner, air or ground patrol, cabin, etc.)

When? 5:45 P.M.

Size of fire then 1 Ac.

What action did he take? Called Chief Warden

When did Reporting Officer get there? 5:55 P.M. June 8

(Hour) (Date)

What action did he take? Started

suppression with back tanks

Distance Reporting Officer travelled to fire: Car Five miles.

Horseback miles. Etc. miles. Total Five miles.

Distance from Headquarters to fire 4.9 miles. Details of prosecutions (if any) R.C.M.P., still investigating - Bridgetown R.C.M.P. Detachment.

(Give particulars as to guilty persons, convictions, fines, etc.)

DETAILS OF FIRE FIGHTING:

Time fire-fighting commenced 6:00 P.M., June 8, 1973

(Hour) (Date)

Size of fire then 1 Ac.

Time fire under control 6:30 P.M. June 8/73

(Hour) (Date)

Size of fire then 1 Ac.

Time completely extinguished 7:00 P.M. 8 June 73

(Hour) (Date)

Time patrol stopped 9:30 P.M.

Perimeter of fire when fire-fighting commenced 20 yd.

Perimeter when controlled 30 yd.

Fireguards—Constructed by hand (1) Nil yd. By horse plough (2) Nil yd.

By other power (3) Nil yd. Line held by pumps only (4) 30 Nil yd.

Trail or natural guard back-fired (5) Nil yd. Total line lost (6) Nil yd.

Total line held (7) Nil yd. Constructed guard back-fired Nil yd.

(Sum of items 5 to 7 should equal item 8 plus item 7.) Number of men employed Nine Rate per hour Park Wages cents

Total man-hours actually on fire-line construction Four Hours X 9 Men = 36 Man Hours.

What class of men were obtained and where? Park Wardens and Park Employees

(Contractors or logging crews, settlers, Indians, manual labour, etc.)

How many were paid by this Department? Eight

How many were paid by other organizations? None

(Name of railway company, lumber company, provincial services, etc.)

Distance men travelled to fire: Car 12 miles. Foot miles. Etc. miles.

Total miles. How long did it take to get men and take them to fire? 25 minutes hours.

Method of fighting fire, and equipment used Back Tanks, Golden Arrow 250, Gal Tanker, Shovels and Pulaski Tools.

Equipment lost or destroyed Nil.

DESCRIPTION OF FIRE BEHAVIOUR:

Material in which fire started, if known: Leaf Litter and Slash-heavy, Hemlock
(Ground leaf litter, etc.) Describe type of forest or other land at point of origin.

Trees 30-40 Feet high, mature timber.

Noting species, size and density of trees, amount of slash, ground vegetation, etc.
Principal fuels in which fire spread: Leaf Litter and Slash, depth of burn in ground 2"-3"
(Leaf litter, moss, slash, etc.) Note depth of burn in ground. If fire involved at all in tree crowns, state species and density of stand, and time of crowning.

If fire spread into types different from that in which it started, describe these types as in previous questions.

Nature of soil and topography: Shallow soil with deep leaves, moss cover.
(Was fragment construction easy, moderately hard or hard?)

Rate of spread of fire: Slow
(Slow, moderate, fast or very fast, for this type of forest or land)

Difficulty of control of fire: Easy
(Easy, moderate, hard or very hard, for this type of forest or land)

Smouldering after control: Moderately hard No
(Easy, moderately hard, or hard to extinguish. Did it last till rain (sl?)

Spot or jump fires: N11
(When did they occur, if at all? How far ahead of main fire?
If the fire burned for two or more days, show, in the space below, the estimated rate of spread and control difficulty separately for each day if possible, and state time of day when it burned. Note whether "breaks" say flames at night or other unusual features.

Date	Forest Index	Forest Type	Speed of Advance	Control Difficulty	Remarks

DAMAGE:

Land burned within National Park, Forest Experiment Station, or Warden District boundary:

Land burned within National Park, Forest Experiment Station or other Federal land									
No. of acre	Inventory Class (Show percent of timber: sap, pole, cutover, etc.)	Area burned, in acres	Timber Conditions						Total Value
			Salvageable			Unsalvageable			
			Under present marketing and normal conditions		Under present marketing and normal conditions		Under present marketing and normal conditions		
			Salvageable in cords	Salvageable in cords	Salvageable in cords	Unsalvageable in cords	Unsalvageable in cords	Unsalvageable in cords	
Merchantable timber									
Cutover timber									
White growth									
Non-Timbered Lands			Total	Total	Total	Total	Total	Total	Total
Old or new burn, non-reproducing			Other property destroyed: buildings, farms, houses, crops, etc. (one fire-fight, etc. Describe, state ownership, if possible, and assign value --						Total value of other property destroyed (10)
Mature forest or cultivated land									
Fields or barns									
Other (Specify)									
Total area			Grand total of log form of (1) and (2)						

Note: Timber values were with the owner and location of the land. Use figures given to your district or report to the nearest office.

Timber conditions on this area before fire: *M ft. b.m. Mature stands of Hemlock, mixed N11
Per cent of timber killed: N11 What per cent of area burned was well stocked with seedlings of merchantable species? 25

Was soil damage light, moderate, or severe? Light

Area burned in this fire outside National Park, Forest Experiment Sta., or Warden Distr. boundary N11 Ac
COST OF EXTINGUISHING:

Hired labor	Provisions and supplies	Freight and Transportation			Total Columns 1 to 5	Warden labor	Other Government labor	Tools lost or damaged	Total Cost Columns 1 to 9
		Wagon	Team	Miscellaneous					
1	2	3	4	5	6	7	8	9	
\$121.16	N11	N11	N11	N11	\$121.16	\$45.00	N11	N11	166.16

WEATHER AND MISCELLANEOUS:

Fire Hazard High, Temp 83°, Wind - West 7.
Weather conditions and Danger Index: No rain for several days.
(Note particularly strength and direction of wind, and amount of rain, if any)

General Remarks: Due to fast action of the townsman and the wardens, this fire was quickly extinguished. Had this fire gotten out of control, a loss of life and property could have been the result. (5)

Signature of Reporting Officer: B. H. Roper
Title: Chief Warden

Date of this report: 15 June 1973
*M ft. b.m. = 1000 feet board measure.

Amundson RLB

DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

FIRE MAP

INSTRUCTIONS: This fire map must accompany written report on form NARS 10-10 for all fires. Complete the heading carefully to correspond with that on form NARS 10-10. Show by an "X" WHERE THE FIRE STARTED. Show also wind direction where the timber, young growth, roads, grass lands, etc. were burned and where the growth recovered. Use a scale suitable to show detail and specify scale in space provided below.

NATIONAL PARK, FOREST EXPERIMENT STATION OR WARDEN DISTRICT

KESIMUKUSIK NATIONAL PARK

NAME OF FIRE (SAME AS ON ACCOMPANYING REPORT)

CANNING FIELD ROAD FIRE

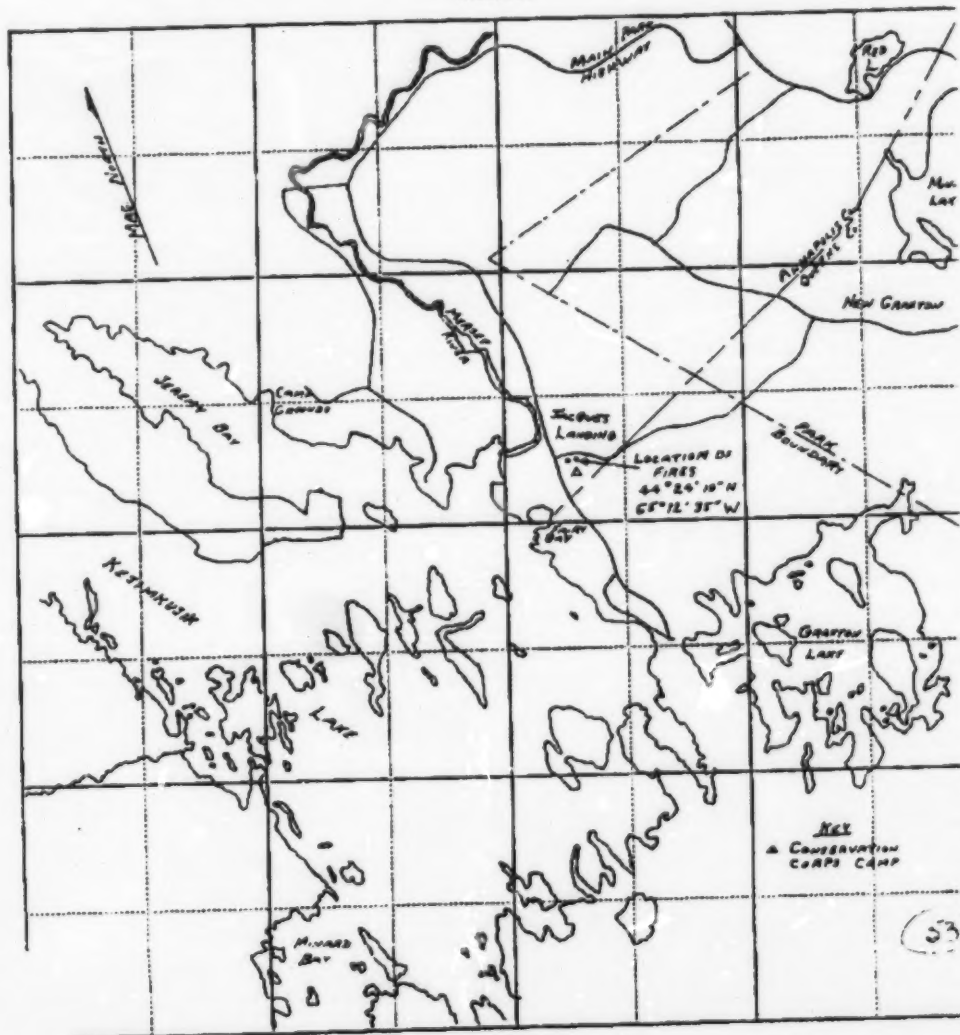
FIRE NUMBER

2

LOCATION (LOCATE BY SECTIONS, ETC., WHERE APPLICABLE; OTHERWISE LOCATE AS WELL AS POSSIBLE)

KESIMUKUSIK NATIONAL PARK (44°24'10"N, 65°12'35"W)

NORTH



Scale: 1 1/4 inches = 1 mile.

REPORTING OFFICER B. N. ROGER

TITLE CHIEF PARK WARDEN

APPAINS AND NORTHERN DEVELOPMENT

REPORT (SHORT FORM)
ON ALL SMOKE REPORTS INVESTIGATED

PRELIMINARY
For fires Classes B, C, C₁, C₂, D

LOCATION: Kejimikujik National Park

DISTRICT: Campground

FIRE Reported on: 8 July
P.M. 12:15 19 77

By: Ground Patrol ☐ Aircraft ☐ Other ☒
Lookout ☐ Railroad ☐ Workman at Outdoor Theatre

REPORTING OFFICER ARRIVED AT: 12:30 July 8 19 77

SUPPRESSION BEGAN: 12:15 P.M. By: Radio maintenance personnel and General Works personnel; campers

FIRE LOCATION (Pinpoint by total description - No fire map required)
About 25 yards up on small path leading to the outdoor theatre from Campground road.

IMMEDIATE ACTION TAKEN BY PATROL
Handtools ☒ Fire Pump ☐ Gasoline cans ☐ Trailer Pump ☐ Water Tank ☒ No. of men: 8
Others (Describe): Stamped out with feet.

FIRE UNDER CONTROL: 12:20 P.M. FIRE OUT: 12:30 P.M. CLASSIFIED CAUSE
Recreation ☐ Woods Operations ☐ Railroad ☐
Settlement ☐ probably caused by cigarette ☒ Other Industries ☐ Incendary ☐
Unknown ☒ Miss. Known ☐ Lightning ☐

PATROL AFTER CONTROL
From: A.M. To: A.M.
P.M. P.M.
Additional Details on Cause: discarded.

Young man seen in area about 20 minutes before fire located.

COST OF EXTINGUISHING (For Warden Office Records.): NOTE: Not required in preliminary report on fires Class B, C₁, C₂, D.

MEN OBTAINED FOR FIRE FIGHTING	No.	Hours	Rate	Amount	DEPARTMENTAL VEHICLES USED	No.	Hours	Rate	Amount
Warden I	378	2	5.75	11.50	Patrol Vehicle				
Warden II					Golden Arrow	1	1.00	1.00	
A/Warden									
Maintenance crew	4	1+		25.00					
TOTAL COST									37.50

FOREST TYPE IN IMMEDIATE AREA
AGE: Mature ☐ Young Timber ☐ Reproduction ☐ Mixed ☒
Conifers: All ☐ 75% ☒ DECIDUOUS: All ☐ 25% ☒
Cut-over ☐ Grass ☒ dead leaves and small underbrush.
Old burn ☐ Other (specify):

VALUES (Not required in preliminary report)
% Killed DBH Height
SPH in cords

SPECIFIC FUEL BURNED
a) ON SURFACE AND/OR b) NOT ON SURFACE
Bark ☒ Duff ☒ Grass ☒ Twigs ☒ Moss ☒ Other ☐ Brush ☐ Slash ☐ Reproduction ☐ Trunk ☐ Branches ☐ Roots ☐ Other ☐

GROUND CONDITIONS
Rock Outcrop ☐ Shallow Soil ☐ Deep Soil ☒ Sand or Gravel ☐ Loam ☐ Clay ☐ Moist ☐ Dry ☐ Depth of Burn ☐

WIND VELOCITY: 5 KPH DANGER INDEX: 9-II WIND FROM: S-W

REMARKS:
Temp. 24°C
Relative humidity 56%

G. F. Robert Lohnes
SIGNATURE OF REPORTING OFFICER
Park Warden July 11

FOREST SERVICE
NATIONAL RESOURCES

FIRE MAP

INSTRUCTIONS: This fire map must accompany written report on form NARS 10-125 for office. Complete the heading exactly to correspond with that on form NARS 10-125. Show by an "X" symbol THE FIRE STARTER. Show the area burned where the timber, young growth, canopy, grass lands, etc. were located and where the guards constructed. Use a scale suitable to show detail and specify scale in space provided below.

NORMAL PARK, FOREST EXPERIMENT STATION OR WARDEN DISTRICT

USE OF FIRE (NAME AS ON ACCOMPANYING REPORT)

FIRE NUMBER

LOCATION (MARKED BY SECTION, ETC., WHERE APPLICABLE; OTHERWISE LOCATE AS WELL AS POSSIBLE)

3-4.5 1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-16-17-18-19-20-21-22-23-24-25-26-27-28-29-30-31-32-33-34-35-36-37-38-39-40-41-42-43-44-45-46-47-48-49-50-51-52-53-54-55-56-57-58-59-60-61-62-63-64-65-66-67-68-69-70-71-72-73-74-75-76-77-78-79-80-81-82-83-84-85-86-87-88-89-90-91-92-93-94-95-96-97-98-99-100-101-102-103-104-105-106-107-108-109-110-111-112-113-114-115-116-117-118-119-120-121-122-123-124-125-126-127-128-129-130-131-132-133-134-135-136-137-138-139-140-141-142-143-144-145-146-147-148-149-150-151-152-153-154-155-156-157-158-159-160-161-162-163-164-165-166-167-168-169-170-171-172-173-174-175-176-177-178-179-180-181-182-183-184-185-186-187-188-189-190-191-192-193-194-195-196-197-198-199-200-201-202-203-204-205-206-207-208-209-210-211-212-213-214-215-216-217-218-219-220-221-222-223-224-225-226-227-228-229-230-231-232-233-234-235-236-237-238-239-240-241-242-243-244-245-246-247-248-249-250-251-252-253-254-255-256-257-258-259-260-261-262-263-264-265-266-267-268-269-270-271-272-273-274-275-276-277-278-279-280-281-282-283-284-285-286-287-288-289-290-291-292-293-294-295-296-297-298-299-300-301-302-303-304-305-306-307-308-309-310-311-312-313-314-315-316-317-318-319-320-321-322-323-324-325-326-327-328-329-330-331-332-333-334-335-336-337-338-339-340-341-342-343-344-345-346-347-348-349-350-351-352-353-354-355-356-357-358-359-360-361-362-363-364-365-366-367-368-369-370-371-372-373-374-375-376-377-378-379-380-381-382-383-384-385-386-387-388-389-390-391-392-393-394-395-396-397-398-399-400-401-402-403-404-405-406-407-408-409-410-411-412-413-414-415-416-417-418-419-420-421-422-423-424-425-426-427-428-429-430-431-432-433-434-435-436-437-438-439-440-441-442-443-444-445-446-447-448-449-450-451-452-453-454-455-456-457-458-459-460-461-462-463-464-465-466-467-468-469-470-471-472-473-474-475-476-477-478-479-480-481-482-483-484-485-486-487-488-489-490-491-492-493-494-495-496-497-498-499-500-501-502-503-504-505-506-507-508-509-510-511-512-513-514-515-516-517-518-519-520-521-522-523-524-525-526-527-528-529-530-531-532-533-534-535-536-537-538-539-540-541-542-543-544-545-546-547-548-549-550-551-552-553-554-555-556-557-558-559-560-561-562-563-564-565-566-567-568-569-570-571-572-573-574-575-576-577-578-579-580-581-582-583-584-585-586-587-588-589-590-591-592-593-594-595-596-597-598-599-600-601-602-603-604-605-606-607-608-609-610-611-612-613-614-615-616-617-618-619-620-621-622-623-624-625-626-627-628-629-630-631-632-633-634-635-636-637-638-639-640-641-642-643-644-645-646-647-648-649-650-651-652-653-654-655-656-657-658-659-660-661-662-663-664-665-666-667-668-669-670-671-672-673-674-675-676-677-678-679-680-681-682-683-684-685-686-687-688-689-690-691-692-693-694-695-696-697-698-699-700-701-702-703-704-705-706-707-708-709-710-711-712-713-714-715-716-717-718-719-720-721-722-723-724-725-726-727-728-729-730-731-732-733-734-735-736-737-738-739-740-741-742-743-744-745-746-747-748-749-750-751-752-753-754-755-756-757-758-759-760-761-762-763-764-765-766-767-768-769-770-771-772-773-774-775-776-777-778-779-780-781-782-783-784-785-786-787-788-789-790-791-792-793-794-795-796-797-798-799-800-801-802-803-804-805-806-807-808-809-810-811-812-813-814-815-816-817-818-819-820-821-822-823-824-825-826-827-828-829-830-831-832-833-834-835-836-837-838-839-840-841-842-843-844-845-846-847-848-849-850-851-852-853-854-855-856-857-858-859-860-861-862-863-864-865-866-867-868-869-870-871-872-873-874-875-876-877-878-879-880-881-882-883-884-885-886-887-888-889-890-891-892-893-894-895-896-897-898-899-900-901-902-903-904-905-906-907-908-909-910-911-912-913-914-915-916-917-918-919-920-921-922-923-924-925-926-927-928-929-930-931-932-933-934-935-936-937-938-939-940-941-942-943-944-945-946-947-948-949-950-951-952-953-954-955-956-957-958-959-960-961-962-963-964-965-966-967-968-969-970-971-972-973-974-975-976-977-978-979-980-981-982-983-984-985-986-987-988-989-990-991-992-993-994-995-996-997-998-999-1000-1001-1002-1003-1004-1005-1006-1007-1008-1009-1010-1011-1012-1013-1014-1015-1016-1017-1018-1019-1020-1021-1022-1023-1024-1025-1026-1027-1028-1029-1030-1031-1032-1033-1034-1035-1036-1037-1038-1039-1040-1041-1042-1043-1044-1045-1046-1047-1048-1049-1050-1051-1052-1053-1054-1055-1056-1057-1058-1059-1060-1061-1062-1063-1064-1065-1066-1067-1068-1069-1070-1071-1072-1073-1074-1075-1076-1077-1078-1079-1080-1081-1082-1083-1084-1085-1086-1087-1088-1089-1090-1091-1092-1093-1094-1095-1096-1097-1098-1099-1100-1101-1102-1103-1104-1105-1106-1107-1108-1109-1110-1111-1112-1113-1114-1115-1116-1117-1118-1119-1120-1121-1122-1123-1124-1125-1126-1127-1128-1129-1130-1131-1132-1133-1134-1135-1136-1137-1138-1139-1140-1141-1142-1143-1144-1145-1146-1147-1148-1149-1150-1151-1152-1153-1154-1155-1156-1157-1158-1159-1160-1161-1162-1163-1164-1165-1166-1167-1168-1169-1170-1171-1172-1173-1174-1175-1176-1177-1178-1179-1180-1181-1182-1183-1184-1185-1186-1187-1188-1189-1190-1191-1192-1193-1194-1195-1196-1197-1198-1199-1200-1201-1202-1203-1204-1205-1206-1207-1208-1209-1210-1211-1212-1213-1214-1215-1216-1217-1218-1219-1220-1221-1222-1223-1224-1225-1226-1227-1228-1229-1230-1231-1232-1233-1234-1235-1236-1237-1238-1239-1240-1241-1242-1243-1244-1245-1246-1247-1248-1249-1250-1251-1252-1253-1254-1255-1256-1257-1258-1259-1260-1261-1262-1263-1264-1265-1266-1267-1268-1269-1270-1271-1272-1273-1274-1275-1276-1277-1278-1279-1280-1281-1282-1283-1284-1285-1286-1287-1288-1289-1290-1291-1292-1293-1294-1295-1296-1297-1298-1299-1300-1301-1302-1303-1304-1305-1306-1307-1308-1309-1310-1311-1312-1313-1314-1315-1316-1317-1318-1319-1320-1321-1322-1323-1324-1325-1326-1327-1328-1329-1330-1331-1332-1333-1334-1335-1336-1337-1338-1339-1340-1341-1342-1343-1344-1345-1346-1347-1348-1349-1350-1351-1352-1353-1354-1355-1356-1357-1358-1359-1360-1361-1362-1363-1364-1365-1366-1367-1368-1369-1370-1371-1372-1373-1374-1375-1376-1377-1378-1379-1380-1381-1382-1383-1384-1385-1386-1387-1388-1389-1390-1391-1392-1393-1394-1395-1396-1397-1398-1399-1400-1401-1402-1403-1404-1405-1406-1407-1408-1409-1410-1411-1412-1413-1414-1415-1416-1417-1418-1419-1420-1421-1422-1423-1424-1425-1426-1427-1428-1429-1430-1431-1432-1433-1434-1435-1436-1437-1438-1439-1440-1441-1442-1443-1444-1445-1446-1447-1448-1449-1450-1451-1452-1453-1454-1455-1456-1457-1458-1459-1460-1461-1462-1463-1464-1465-1466-1467-1468-1469-1470-1471-1472-1473-1474-1475-1476-1477-1478-1479-1480-1481-1482-1483-1484-1485-1486-1487-1488-1489-1490-1491-1492-1493-1494-1495-1496-1497-1498-1499-1500-1501-1502-1503-1504-1505-1506-1507-1508-1509-1510-1511-1512-1513-1514-1515-1516-1517-1518-1519-1520-1521-1522-1523-1524-1525-1526-1527-1528-1529-1530-1531-1532-1533-1534-1535-1536-1537-1538-1539-1540-1541-1542-1543-1544-1545-1546-1547-1548-1549-1550-1551-1552-1553-1554-1555-1556-1557-1558-1559-1560-1561-1562-1563-1564-1565-1566-1567-1568-1569-1570-1571-1572-1573-1574-1575-1576-1577-1578-1579-1580-1581-1582-1583-1584-1585-1586-1587-1588-1589-1590-1591-1592-1593-1594-1595-1596-1597-1598-1599-1600-1601-1602-1603-1604-1605-1606-1607-1608-1609-1610-1611-1612-1613-1614-1615-1616-1617-1618-1619-1620-1621-1622-1623-1624-1625-1626-1627-1628-1629-1630-1631-1632-1633-1634-1635-1636-1637-1638-1639-1640-1641-1642-1643-1644-1645-1646-1647-1648-1649-1650-1651-1652-1653-1654-1655-1656-1657-1658-1659-1660-1661-1662-1663-1664-1665-1666-1667-1668-1669-1670-1671-1672-1673-1674-1675-1676-1677-1678-1679-1680-1681-1682-1683-1684-1685-1686-1687-1688-1689-1690-1691-1692-1693-1694-1695-1696-1697-1698-1699-1700-1701-1702-1703-1704-1705-1706-1707-1708-1709-1710-1711-1712-1713-1714-1715-1716-1717-1718-1719-1720-1721-1722-1723-1724-1725-1726-1727-1728-1729-1730-1731-1732-1733-1734-1735-1736-1737-1738-1739-1740-1741-1742-1743-1744-1745-1746-1747-1748-1749-1750-1751-1752-1753-1754-1755-1756-1757-1758-1759-1760-1761-1762-1763-1764-1765-1766-1767-1768-1769-1770-1771-1772-1773-1774-1775-1776-1777-1778-1779-1780-1781-1782-1783-1784-1785-1786-1787-1788-1789-1790-1791-1792-1793-1794-1795-1796-1797-1798-1799-1800-1801-1802-1803-1804-1805-1806-1807-1808-1809-1810-1811-1812-1813-1814-1815-1816-1817-1818-1819-1820-1821-1822-1823-1824-1825-1826-1827-1828-1829-1830-1831-1832-1833-1834-1835-1836-1837-1838-1839-1840-1841-1842-1843-1844-1845-1846-1847-1848-1849-1850-1851-1852-1853-1854-1855-1856-1857-1858-1859-1860-1861-1862-1863-1864-1865-1866-1867-1868-1869-1870-1871-1872-1873-1874-1875-1876-1877-1878-1879-1880-1881-1882-1883-1884-1885-1886-1887-1888-1889-1890-1891-1892-1893-1894-1895-1896-1897-1898-1899-1900-1901-1902-1903-1904-1905-1906-1907-1908-1909-1910-1911-1912-1913-1914-1915-1916-1917-1918-1919-1920-1921-1922-1923-1924-1925-1926-1927-1928-1929-1930-1931-1932-1933-1934-1935-1936-1937-1938-1939-1940-1941-1942-1943-1944-1945-1946-1947-1948-1949-1950-1951-1952-1953-1954-1955-1956-1957-1958-1959-1960-1961-1962-1963-1964-1965-1966-1967-1968-1969-1970-1971-1972-1973-1974-1975-1976-1977-1978-1979-1980-1981-1982-1983-1984-1985-1986-1987-1988-1989-1990-1991-1992-1993-1994-1995-1996-1997-1998-1999-2000-2001-2002-2003-2004-2005-2006-2007-2008-2009-2010-2011-2012-2013-2014-2015-2016-2017-2018-2019-2020-2021-2022-2023-2024-2025-2026-2027-2028-2029-2030-2031-2032-2033-2034-2035-2036-2037-2038-2039-2040-2041-2042-2043-2044-2045-2046-2047-2048-2049-2050-2051-2052-2053-2054-2055-2056-2057-2058-2059-2060-2061-2062-2063-2064-2065-2066-2067-2068-2069-2070-2071-2072-2073-2074-2075-2076-2077-2078-2079-2080-2081-2082-2083-2084-2085-2086-2087-2088-2089-2090-2091-2092-2093-2094-2095-2096-2097-2098-2099-2100-2101-2102-2103-2104-2105-2106-2107-2108-2109-2110-2111-2112-2113-2114-2115-2116-2117-2118-2119-2120-2121-2122-2123-2124-2125-2126-2127-2128-2129-2130-2131-2132-2133-2134-2135-2136-2137-2138-2139-2140-2141-2142-2143-2144-2145-2146-2147-2148-2149-2150-2151-2152-2153-2154-2155-2156-2157-2158-2159-2160-2161-2162-2163-2164-2165-2166-2167-2168-2169-2170-2171-2172-2173-2174-2175-2176-2177-2178-2179-2180-2181-2182-2183-2184-2185-2186-2187-2188-2189-2190-2191-2192-2193-2194-2195-2196-2197-2198-2199-2200-2201-2202-2203-2204-2205-2206-2207-2208-2209-2210-2211-2212-2213-2214-2215-2216-2217-2218-2219-2220-2221-2222-2223-2224-2225-2226-2227-2228-2229-2230-2231-2232-2233-2234-2235-2236-2237-2238-2239-2240-2241-2242-2243-2244-2245-2246-2247-2248-2249-2250-2251-2252-2253-2254-2255-2256-2257-2258-2259-2260-2261-2262-2263-2264-2265-2266-2267-2268-2269-2270-2271-2272-2273-2274-2275-2276-2277-2278-2279-2280-2281-2282-2283-2284-2285-2286-2287-2288-2289-2290-2291-2292-2293-2294-2295-2296-2297-2298-2299-2300-2301-2302-2303-2304-2305-2306-2307-2308-2309-2310-2311-2312-2313-2314-2315-2316-2317-2318-2319-2320-2321-2322-2323-2324-2325-2326-2327-2328-2329-2330-2331-2332-2333-2334-2335-2336-2337-2338-2339-2340-2341-2342-2343-2344-2345-2346-2347-2348-2349-2350-2351-2352-2353-2354-2355-2356-2357-2358-2359-2360-2361-2362-2363-2364-2365-2366-2367-2368-2369-2370-2371-2372-2373-2374-2375-2376-2377-2378-2379-2380-2381-2382-2383-2384-2385-2386-2387-2388-2389-2390-2391-2392-2393-2394-2395-2396-2397-2398-2399-2400-2401-2402-2403-2404-2405-2406-2407-2408-2409-2410-2411-2412-2413-2414-2415-2416-2417-2418-2419-2420-2421-2422-2423-2424-2425-2426-2427-2428-2429-2430-2431-2432-2433-2434-2435-2436-2437-2438-2439-2440-2441-2442-2443-2444-2445-2446-2447-2448-2449-2450-2451-2452-2453-2454-2455-2456-2457-2458-2459-2460-2461-2462-2463-2464-2465-2466-2467-2468-2469-2470-2471-2472-2473-2474-2475-2476-2477-2478-2479-2480-2481-2482-2483-2484-2485-2486-2487-2488-2489-2490-2491-2492-2493-2494-2495-2496-2497-2498-2499-2500-2501-2502-2503-2504-2505-2506-2507-2508-2509-2510-2511-2512-2513-2514-2515-2516-2517-2518-2519-2520-2521-2522-2523-2524-2525-2526-2527-2528-2529-2530-2531-2532-2533-2534-2535-2536-2537-2538-2539-2540-2541-2542-2543-2544-2545-2546-2547-2548-2549-2550-2551-2552-2553-2554-2555-2556-2557-2558-2559-2560-2561-2562-2563-2564-2565-2566-2567-2568-2569-2570-2571-2572-2573-2574-2575-2576-2577-2578-2579-2580-2581-2582-2583-2584-2585-2586-2587-2588-2589-2590-2591-2592-2593-2594-2595-2596-2597-2598-2599-2600-2601-2602-2603-2604-2605-2606-2607-2

DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

FOREST FIRE REPORT (SHORT FORM)

COMPLETE FOR ALL SMOKE REPORTS INVESTIGATED

PRELIMINARY

For fires Classes B, C, D

(Less than 1/2 acre)

LOCATION

Still Brook portage in Kejinkujik National Park

DISTRICT

North

FIRE REPORTED ON

A.M.
3 P.M. May 22 1982

By

Ground Patrol ☐
Lookout ☒Aircraft ☐
Railroad ☐Other ☐

REPORTING OFFICER ARRIVED AT

A.M.
P.M. 6:00 May 22 1982

SUPPRESSION BEGAN

A.M.
P.M. 3:04

By

A.M.
P.M. 6 Park Visitors

FIRE LOCATION (Prepared by local description - No fire map required)

14 Meters from the south end of Still Brook portage.

Grid designation 174 246 Topo Map Sheet 21 A/6 N.S.

IMMEDIATE ACTION TAKEN BY PATROL

Handtools ☐ Fire Pump ☐ Chainsaw ☐ Trailer Pump ☐ Water Tank ☐

No. of men

6

Others (Describe) Picnic coolers and other available materials

FIRE UNDER CONTROL

FIRE OUT

CLASSIFIED CAUSE

A.M.
P.M. 3:15A.M.
P.M. 3:30Recreation ☐Woods Operations ☐Railroad ☐

PATROL AFTER CONTROL

From:

To:

A.M.

A.M.

P.M. 16:00 hrs.

P.M. 18:00 hrs.

Unknown ☒Misc. Known ☐Lightning ☐

ADDITIONAL DETAILS ON CAUSE

A large number of Park visitors were using the portage in the day, probable cause - carelessly thrown cigarette.

COST OF EXTINGUISHING (For Warden Office Records) NOTE: Not required in preliminary report on fires Class B, C, D.

MEN OBTAINED FOR FIRE FIGHTING	No.	Hours	Rate	Amount	DEPARTMENTAL VEHICLES USED	No.	Hours	Rate	Amount
Warden I					Patrol Vehicle				
Warden II					Tank Truck				
A/Warden									
					TOTAL COST				

FOREST TYPE IN IMMEDIATE AREA

AGE: Mature ☐Young Timber ☒Reproduction ☐Mixed ☐

VALUES

LOST

(Not required in preliminary report)

% Killed

DBH

Height

Conifers

All

or

% 50

DECIDUOUS

All

or

% 50

Ground cover only

Culm cover ☒Grass ☐

Open mixed stand with thick

Old burn ☐

Other (specify)

Laurel understory.

SPECIFIC FUEL BURNED

a) ON SURFACE

AND/OR b) NOT ON SURFACE

Bark

Duff

Grass

Twigs

Moss

Other

Brush

Slash

Reproduction

Trunk

Branches

Stems

Other

GROUND CONDITIONS

Rock Outcrop

Shallow Soil

Deep Soil

Sand or Gravel

Loam

Clay

Mud

Dry

Depth of Burn

Surface only

WIND VELOCITY

15 km. hr.

DANGER INDEX

Low (1)

WIND FROM

N.W.

REMARKS:

John Bacon

SIGNATURE OF REPORTING OFFICER

1987 Fire at Big Dam Lake – No fire report available

.....

Environnement Canada
Service des parcs

MEMORANDUM - NOTE DE SERVICE

/2:023/007232

JOHN LOGAN
GENERAL WORKS MANAGER
KEJINKUIK NATIONAL PARK

Security Classification
Classification de sécurité

Our File - Notre référence
6222-1

Your File - Votre référence

Date
July 02, 1991

JORDAN WENTZELL
CHIEF PARK WARDEN
KEJINKUIK NATIONAL PARK

JECT
ET FIRE - NORWAY ISLAND

As you are aware John, we had a fire on Norway Island Saturday as a result of a lightening strike the night before. All fires have the potential to become serious and this one was no exception.

The following members of your staff responded to our call and did a cracker-jack job at extinguishing this fire:

Howard Ford
Allan Vanboldt
Charlie Hearn
Allan Love
Laurie Ford
Wade Merry

Fire on June 29th

Would you please pass on our appreciation and thanks for their assistance.

JRW
J.R. Wentzell
Chief Park Warden
Kejinkujik National Park

cc Superintendent

Author: Ian Morrison at Kejimikujik
Date: 8/12/97 11:43 AM
Priority: Normal
TO: Blair Pardy at HALIFAX-RO
CC: Mark Heathcott at JLN4-HULL
Subject: Fire Reports

----- Message Contents -----

Fire reports for Kejimikujik 1997:

Provincial fires actioned by park crews:

Lansdown No.1: location Lat:44 35 30, Long:65 41 30
UTM 4941800 286000

This was a man caused fire which started on the 1st. of August (size, spot) it was actioned on request from provincial authorities. The I.A. crew, (2 men) assisted by 206 responded.

Lansdown No.2 Fire: Location: Lat:44 35 35, Long:65 41 35
UTM 4941100 286000

This fire was man caused, size approx.50 ha. It started on August 1st. This fire was actioned by the park I.A. crew (2 men), transport by 206. Assistance had been requested by provincial authorities.

Victory Rd. Fire: Location: Lat: 44 33 40 Long: 65 30 30
UTM 4937100 305000

This fire started on the 31st of July, it was man caused and was approx. 2ha. in size. The fire was actioned by the park I.A. crew with wajax mark iii, assisted by the 206. Assistance had been requested by provincial authorities.

In the above cases fire personnel were transported by the 206 helicopter, crews were set into the fires, no aerial disembarking was required.

Kejimikujik Fire:

Keji 97-1 Fire: Location: Lat:44 24 30 Long: 65 13 00
UTM 4919500 322900

This was a lightning caused spot fire which started on August 3rd. This fire was actioned by the park I.A. crew, on foot. Hand tools and back tanks were used to extinguish this fire.



Fire Report - Update

Park Status

Kejimikujik

Fire = 99KE001

Name :	Luxton Lake	LandOwner :	Federal
Cause :	Lightning	Start date :	6/22/99
Latitude :	44.3569	Longitude :	65.3333
Inside Park :	Yes	Agreement :	No
Status :	Extinguished	Response :	Full
Area burned :	0.1 hectares	Last Update :	6/24/99 3:34:37 PM

Initial Attack

Agency 1 : Parks Canada		
Agency 2 : NSDNR		
Airtanker : 0	Rapattack : 0	Helitack : 1
Ground Crew : 3	Pumper Crew : 0	
Preparedness Level : Red Alert		Discovery Agent : Lookout
Last Update : 6/25/99 1:25:33 PM		

Modify

Stage	Date & Time	Known	Size	Rate of Spread	Length of flames
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Weather Particulars

State	Date & Time	Known	StationID	FFMC	DMC	DC	ISI
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Fire Report - Update

Park Status

Kejimikujik

Fire = 99KE002

Name :	Hilchemakaar Lake	LandOwner :	Federal
Cause :	Lightning near outflow of Little Peckowiesk	Start date :	6/23/99
Latitude :	44.275	Longitude :	65.2202
Inside Park :	Yes	Agreement :	No
Status :	Extinguished	Response :	Full
Area burned :	0.1 hectares	Last Update :	6/24/99 3:30:00 PM

Initial Attack

Agency 1 : NSDNR		
Agency 2 : Parks Canada		
Airtanker : 0	Rapattack : 0	Helitack : 1
Ground Crew : 3	Pumper Crew : 0	
Preparedness Level : Red Alert	Discovery Agent : Lookout	
Last Update : 6/25/99 1:29:15 PM		

Modify

Stage	Date & Time	Known	Size	Rate of Spread	Length of flames
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Weather Particulars

State	Date & Time	Known	StationID	FFMC	DMC	DC	ISI
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Parcs Canada, région de l'Atlantique, produira trois séries de rapports en sciences des écosystèmes afin de communiquer de nouvelles données scientifiques, de consigner des données scientifiques, et de résumer les connaissances existantes ou de formuler des recommandations d'ordre technique. La fonction principale et le public visé détermineront la série dans laquelle un rapport sera publié. Chaque série contiendra des informations scientifiques et techniques qui viendront enrichir les connaissances existantes, mais ne pourraient être publiées dans les revues professionnelles en raison de leur présentation.

- **Les Rapports techniques en sciences des écosystèmes - Parcs Canada** favoriseront la diffusion à grande échelle d'information scientifique et technique tirée des études spéciales effectuées par Parcs Canada. La matière traitée et la série reflètent l'intérêt et les politiques de Parcs Canada dans de nombreux aspects des sciences des écosystèmes. La série comprendra des inventaires d'écosystèmes, des inventaires de ressources, des études diverses, des relevés sur des espèces ou des guildes et des concepts innovateurs de gestion.
- **Les Rapports d'études en matière de sciences des écosystèmes - Parcs Canada** permettront la publication de comptes rendus, de bibliographies et d'études d'options en matière de gestion faites par Parcs Canada. Les descriptions et les analyses de ressources sont aussi publiées dans cette série, en entier ou en partie.
- **Les Rapports de surveillance et de données relatives aux écosystèmes - Parcs Canada** offriront un moyen de présenter des compilations de données sans analyse détaillée. En général, ce genre de compilation sert à appuyer des publications scientifiques ou des rapports techniques en sciences des écosystèmes. Parcs Canada publiera dans cette série des données brutes qui ne sont pas incluses dans une banque de données nationale et qui méritent l'archivage.

Rapports en sciences des écosystèmes sont publiés dans la langue officielle choisie par l'auteur en fonction du public visé, avec un résumé dans la deuxième langue officielle.

Objectifs

Ces séries de rapports serviront à :

- communiquer les résultats des recherches effectuées en sciences des écosystèmes aux scientifiques et aux gestionnaires, ainsi qu'aux membres du public que les activités entreprises par Parcs Canada en écologie et en conservation intéressent.
- offrir des publications professionnelles, crédibles et précises qui seront soumises à l'évaluation par les pairs.
- favoriser la diffusion de l'information, la créativité, l'efficacité et le travail d'équipe dans les projets de recherche.

Évaluation par les pairs

Le rédacteur nommera deux lecteurs choisis, dans la mesure du possible, parmi le personnel scientifique de Parcs Canada, qui seront chargés de faire une critique de chaque manuscrit. On fera appel à des lecteurs de l'extérieur en raison de l'expertise exigée, du temps disponible et de l'objectivité nécessaire. Les lecteurs renverront le manuscrit au rédacteur en y joignant leurs commentaires par écrit. Le rédacteur renverra le manuscrit à son ou à ses auteurs avec les commentaires des lecteurs. L'auteur prendra connaissance des commentaires et tiendra compte de ceux avec lesquels il est d'accord, puis il retournera le manuscrit révisé au rédacteur en lui expliquant par écrit pourquoi il n'a pas tenu compte de certains commentaires. Le rédacteur enverra ensuite le manuscrit au garde de parc en chef, ou, s'il s'agit d'employés du bureau régional, au superviseur immédiat de l'auteur, pour faire approuver la publication et l'impression du manuscrit. Dans le cas de publications de moindre importance, le rédacteur peut, à sa discrétion, décider de ne pas avoir recours à des lecteurs; lui-même et le superviseur immédiat de l'auteur serviront alors de lecteurs. En cas de désaccord entre l'auteur et le rédacteur au sujet du manuscrit, c'est le gestionnaire ministériel principal qui tranchera.

Directives à l'intention des auteurs

Ces séries de rapports seront consacrées à la publication de travaux effectués dans la région de l'Atlantique en science des écosystèmes et seront mises à la disposition de tous les employés de Parcs Canada, du ministère du Patrimoine canadien, de leurs collaborateurs ou de toute personne qui travaille pour le compte de Patrimoine canadien.

Les auteurs soumettront au rédacteur régional une copie de leur manuscrit sur support en papier, une version sur disquette en WordPerfect Windows ou DOS et le nom de trois lecteurs éventuels qui ne connaissent pas le manuscrit.

Pour de plus amples renseignements, communiquez avec :

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